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BLUE VALLEY INDUSTRIAL CORRIDOR SOILS BACKGROUND STUDY REPORT

BROWNFIELDS SHOWCASE PROJECT

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LIST OF ABBREVIATIONS AND ACRONYMS

AML	Analytical Management Laboratory, Inc.
ASTM	American Society for Testing Materials
ATSDR	Agency for Toxic Substance and Disease Registry
bgs	below ground surface
CALM	cleanup levels for Missouri
CEC	cation exchange capacity
CME	Central Mining Equipment
EPA	Environmental Protection Agency
FoD	frequency of detection
ICP	inductive coupled plasma
ID	inside diameter
KCD	Kansas City District
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MB	method blank
MDNR	Missouri Dept. of Natural Resources
MS	matrix spike
MSD	matrix spike duplicate
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
% R	percent recovery
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
QCSR	quality control summary report
QL	quantitation limit
RAGS	Risk Assessment Guidance for Superfund
RPD	relative percent difference
SCS	Soil Conservation Service
SIM	selective ion method
STARC	soil target concentration
TAL	target analyte list
TOC	total organic carbon
USACE	US Army Corps of Engineers
USCS	unified soil classification system
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency
UTL	upper tolerance limit
VCP	Voluntary Cleanup Program

1.0 INTRODUCTION

1.1 STUDY OBJECTIVE

This report presents the results of the background study conducted for the Blue Valley Industrial Urban Renewal Project. The objective of the study was to characterize the chemical and geotechnical characteristics of the native soils surrounding the Renewal Project area for use by property owners and/or developers conducting environmental investigations.

1.2 REPORT ORGANIZATION

Section 2 provides general information on the Blue Valley Brownfields project and on the regulatory setting. The rationale for the study design, including a description of the types or populations of soils in the area, analytical data needs, the number of samples required, and the criteria for selecting sampling locations are explained.

Section 3 describes field activities and the drilling and sampling techniques used.

Section 4 evaluates the analytical data quality.

Section 5 summarizes the analytical results.

Section 6 presents the statistical evaluation of the data. This includes descriptions of the data populations evaluated, the probability plots used to visually inspect the data, Shapiro Wilk and Lilliefors tests used to determine population distributions, outlier tests applied to extreme values, and determination of the upper bounds on concentrations selected to represent background.

Section 7 provides a summary of the study and discusses applications.

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2.0 PROJECT BACKGROUND

2.1 BLUE VALLEY INDUSTRIAL CORRIDOR RENEWAL

The soils background study was conducted for the Blue Valley Industrial Corridor Renewal Project (Renewal Project) located along the Big Blue River in Kansas City, Missouri. The Renewal Project area is generally bounded by: 29th Street, Big Blue River, and I-70 to the north; Coal Mine Road to the south; Van Brunt Boulevard, Railroad Right of Way, and Wheeling Road to the west; and Manchester Trafficway to the east (Figures 1 and 2).

The Renewal Project is funded as a Brownfields Showcase Project and represents a collaborative effort between the City of Kansas City, the US Environmental Protection Agency, the US Army Corps of Engineers, and Missouri State agencies. The primary goal of the Renewal Project is to encourage industrial redevelopment of this area. Because of blighting and suspected chemical contamination due to historical uses, some properties will require environmental studies prior to development. Future environmental studies for development will determine chemical levels in various media (e.g., surface soil, subsurface soil, groundwater) and whether these chemical levels pose a human health risk or a threat to the environment.

2.2 REGULATORY INFORMATION

While federal, state, or local agency regulations apply to some sites in the Renewal Project Area, other sites will enter into the Missouri Department of Natural Resources (MDNR) Voluntary Cleanup Program (VCP). The VCP program's risk-based approach to establishing cleanup is described in Cleanup Levels for Missouri (CALM) (MDNR, 1998 and 2001). The CALM guidance document provides a risk-based tiered approach to determining levels of contamination in soil media and groundwater that might threaten human health or the environment under certain land use conditions.

In a Tier 1 evaluation, data collected at a site are compared to published chemical-specific cleanup goals for soil and groundwater. Cleanup goals fall into three land use scenarios: Scenario A – residential or "unrestricted"; Scenario B – commercial with children present; and Scenario C – industrial. If chemical levels at a site are greater than the published cleanup goals, then a human health or environmental threat may exist. The property owner and/or developer have the option to clean to the published goals or to move on to a higher tier evaluation.

Conducting a Tier 2 evaluation requires prior notice to MDNR VCP and generally involves developing soil target concentrations (STARCs) that are specific to the site. This is accomplished by replacing the conservative assumptions used in the Tier 1 calculations with site-specific information. These assumptions may relate to source characteristics (e.g., depth and width of contamination in the subsurface) or site geology and hydrology. Thus in a Tier 2, soil physical parameters and aquifer characteristics for a site may be determined and used in developing STARCs. A Tier 2 evaluation also allows studies to determine background concentrations of chemicals in native soil. Should chemical concentrations in site data exceed the developed Tier 2 levels, a Tier 3 evaluation may be pursued pending approval by MDNR. A Tier 3 evaluation requires substantially more effort and may involve the use of computer code fate and transport models or uncertainty analysis.

The soils background information provided in this report is for use by property owners and developers during environmental investigations under CALM or in other regulatory settings.

2.3 STUDY DESIGN AND RATIONALE

2.3.1 Soils in Blue Valley

Based on a review of Soil Survey of Jackson County, Missouri (USDA SCS, 1984), the soil map units listed below are predominant in the Renewal Project area. Figure 3 shows units and associations in the Blue River Valley.

- 10F Snead Rock Outcrop Complex (14-30% slope)
- 30 Keenebec Silt Loam
- 36 Bremer Silt Loam
- 38 Wiota Silt Loam
- 54E Knox Silt Loam (14-20% slope)
- 60C Sibley-Urban Land Complex (5-9% slope)
- 61C Knox-Urban Land Complex (5-9% slope)
- 61D Knox-Urban Land Complex (9-14% slope)
- 65F Snead-Urban Land Complex (9-30% slope)
- 69A Urban Land, Bottom Land (0-3% slope)
- 102 Udifluvents (nearly level)

With limited exceptions, all units within the Blue River valley fall into one of the following established soil associations:

- Knox-Sibley-Urban Association - Urban land and deep, gently sloping to steep, well-drained soils that formed in loess on uplands.

- Snead-Menfro-Oska Association - Moderately deep and deep, gently sloping to steep, well drained and moderately drained soils that formed in loess or residuum from shale and limestone on upland.

- Keenebec-Colo-Bremer Association - Deep, nearly level, moderately well drained and poorly drained soils that formed in alluvium on flood plains and terraces.

One exception is a small area of soil classified in the Higginsville-Sibley-Sharpsburg Association, which is located approximately 2 miles south of the Renewal Project area in the vicinity of the Swope Park amphitheater. This association is also seen to the southeast, but is within another watershed.

The other exception is udifluvents. Udifluvents are fill areas on flood plains that consist of mixtures of silty soil and manmade materials, usually mixed by machinery (USDA SCS, 1984).

The background study was designed to evaluate the chemical and physical properties of the three soil associations listed above, separately, since each association may represent a distinct sample population. As explained in United States Environmental Protection Agency guidance documents (USEPA, 1995a and 1995b) chemical concentrations vary depending on the physical, chemical, and biological processes that effect parent geological material. Grouping the data by association would reduce the variation in distributions and thus, require fewer samples per population. Geotechnical data collection was planned to confirm the physical characteristics of soil samples and confirm that the samples, grouped by association, represented the same/similar population.

Since udifluvents are a mixture of different soils and manmade material, the variation in chemical and physical soil properties was expected to be great and therefore would require a greater number of samples to reduce variability in the datasets. Since including fill as a target population would be costly, it was assumed that if the source of fill is neighboring soil associations, then the ranges of chemical concentrations seen in the three associations sampled would serve to bracket what might be considered background for udifluvent soil. Concentrations in fill that exceed this bracket would less likely be related to background and would more likely be evidence of a site-related release.

2.3.2 Data Needs

2.3.2.1 Chemical Analyses

The study included chemical analyses for the following inorganic constituents following EPA SW-846 Method 6010B/7000: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, total chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

Hexavalent chromium (Cr^{+6}) is typically less abundant in soil than trivalent chromium (Cr^{+3}), but it is more toxic (ATSDR, 1993; USEPA, 1992a and 1994). When the fraction of hexavalent chromium in a total chromium analysis is unknown, it is often overestimated when developing risk-based cleanup goals so as to be protective. This study planned to determine the typical concentrations of Cr^{+6} found in these soils. Hexavalent chromium was analyzed using EPA Method 3060A/7196A in ten percent of the soil samples collected.

Polynuclear aromatic hydrocarbons (PAHs) were proposed for analysis (in surface soil only) using EPA Method 8270C - selective ion method (SIM) for a lower detection limit. SIM can achieve concentrations in nanograms per kilogram (ng/kg) or parts per trillion. PAHs are ubiquitous in the environment, forming as a result of incomplete combustion. Sources are both natural (e.g., forest fires) and manmade (e.g., fuel burning). Most of the PAHs in soil are believed to result from atmospheric deposition after local and long-range transport (ATSDR, 1995). This is supported by the presence of PAHs in soil of regions that are remote from industrial activity (Thomas, 1986). However, PAH concentrations are documented to be highest in urban areas. Vehicle exhaust, asphalt, emissions from the wearing of tires, asphalt, and materials such as ash, slag, or sewage sludge used as construction fill all add to PAHs in an urban environment. This list, which is taken from ATSDR (1995), is not exhaustive. Although the CALM guidance limits background to naturally occurring chemical levels, other agencies have considered anthropogenic (or manmade) levels for background. For example, *Risk Assessment Guidance for Superfund, Volume 1 – Human Health Evaluation Part A* (RAGS) considers anthropogenic levels that are present due to non-site related sources, such as automobiles and industry, as background (USEPA, 1989a; pg. 4-5). The work plan for this study provided a literature review that supports the characterization of ubiquitous PAH levels in industrialized urban areas as non-site related background.

Other chemical analytes in the design included pH by EPA Method 9045C, cation exchange capacity (CEC) by EPA Method 9081C, and total organic carbon (TOC) by ASTM D2974.

2.3.2.2 Geotechnical Characteristics

Soil geotechnical analyses were planned using the following methods:

- Moisture Content (ASTM D2216)
- Bulk Density (ASTM D2937)

- Sieve Analysis (ASTM D422)
- USDA Classification

Soil physical characteristics would not only confirm that soil samples are grouped by similar populations, but also provide information for use in environmental studies on "media transfer". Media transfer, in this instance, refers to the migration of chemicals from a solid form in soil to either a vapor form in air or a leachate form in groundwater. However, this application of the geotechnical data is limited to environmental projects that are *not* located in udifluvent soil or fill, since moving and mixing can impact soil physical characteristics.

2.3.3 Sample Population Size

A commonly used statistical approach for determining chemical background concentrations is the construction of tolerance intervals (USEPA, 1989b, 1992b, and 2002; MI, 1994; Singh, 1994 and 1999). This statistical technique establishes an upper limit on a distribution of background concentrations. This upper limit then represents the maximum concentration still considered within the normal range of background concentrations for that chemical. If a sample result from an environmental site is compared and found to be greater than the upper-end of the distribution, then the sample is likely site-related and not representative of background.

An upper tolerance limit (UTL) is calculated using the following equation:

$$UTL = x + Ks$$

where:
x is the mean
S is the standard deviation
K is the tolerance factor based on population size (n), confidence, and coverage

USEPA (1989b) recommends using tolerance factors for a 95% confidence and 95% coverage. This means that one is 95% confident that at least 95% of data points (in this case, background chemical concentrations) will be less than the UTL value. Tables of K values calculated for varying levels of confidence and coverage have been published (Lieberman, 1958; Guttman, 1970). Each set of tables includes K values based on sample population sizes (n), beginning with a population size as few as two. It is possible to have few samples and still calculate a meaningful UTL because K adjusts the standard deviation for the uncertainty associated with a smaller population size. Eight is considered by USEPA to be an adequate sample population size for determining UTLs (1989b).

The population size proposed for characterizing background concentrations of metals was therefore a minimum of eight samples per each of three sampling intervals per each of three soil associations. This design allowed an adequate number of samples to test several hypotheses about sample populations. (See later section on statistical evaluation.) Since the predominant source of PAHs in surface soil is likely to be atmospheric deposition and not necessarily related to parent geological material, the 24 surface soil samples were assumed to represent the same population.

2.3.4 Field Sampling Design

A classic or stratified sampling design is often recommended for determining representative concentrations (USEPA, 1992 and 2000; Gilbert, 1987). Stratified random is a design where target populations are divided into regions or strata that are expected to have similar characteristics, as is the case with the soil associations in this study.

The area identified for sampling extends from the Renewal Project area south to Swope Park. Sampling locations and alternatives within each soil association were selected after reviewing the historical aerial photograph inventory from 1936 to 1982 (USEPA, 1990) and after visual inspection in the field. Aerial photograph review was conducted to avoid placing sampling points on property, which may have been historically used for industrial purposes, and/or which may contain fill or other disturbed soils not representative of background conditions. The specific sample point at each of the locations was selected in the field based upon best professional judgment and evidence of minimal anthropogenic impact (e.g., mature trees nearby).

Samples for metals analyses were collected from three intervals in each of the eight borings in each of the three soil associations (72 samples). Sampling intervals were from 0 to 12 inches below ground surface (bgs), 24 to 36 inches bgs, and 48 to 60 inches bgs. PAHs were only analyzed in surface soil samples (a total of 24). Total organic carbon and soil pH were measured in all 72 samples. CEC was analyzed in a third of all samples collected from each soil association.

Shelby tubes were planned in half of all borings at 0-36 inches bgs and at 36-60 inches bgs for sieve analysis, hydrometer (if warranted by particle size), moisture content, and bulk density.

2.4 PLAN DEVELOPMENT AND REVIEW

A conceptual design work plan was submitted for EPA and MDNR review. Following meetings and discussions, the conceptual design was revised to address comments and then finalized in February 2001. The actual project work plan was developed and submitted for approval in May 2001; it included sampling and analysis, quality assurance, quality control, health and safety, and data evaluation plans. The plan was reviewed and finalized in September 2001. Copies of the project plan are available upon request through the City of Kansas City Brownfields Office.

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3.0 FIELD ACTIVITIES

3.1 INTRODUCTION

During September 2001, USACE-KCD completed sampling for the Blue Valley Soils Background Study in an area extending east of Prospect Street to Raytown Road and south of I-70 to Swope Park. The purpose of the study was to characterize the chemical and geotechnical characteristics of native soils surrounding the Blue Valley Industrial Renewal Project Area for use in future environmental investigations. While field activities were scheduled for completion in two weeks, rainy conditions, site access, and other circumstances caused delays. Some sampling locations were abandoned due to auger refusal or when the core contained a large percentage of asphalt or rubble. Daily Exploration Reports describe weather and site conditions and are provided in Appendix B1.

3.2 SAMPLING LOCATIONS

Thirty Kansas City or Jackson County parcels and right of ways were identified as sampling locations during the work plan development. These included eight primary locations with two alternates for each of three soil associations, the Keenebec-Colo-Bremer Association (KCB), Knox-Sibley-Urban Association (KSU), and the Snead-Menfro-Oska Association (SMO). These sampling sites were staked and utilities were cleared a week prior to mobilization. During field activities, however, site conditions necessitated abandoning several of the locations and the alternatives were not enough. Additional alternative sites were identified and approval coordinated with the city and state. Utilities were cleared again prior to sampling. Table 2 identifies the final locations included in the study. Photographs of each sampling location are provided in Appendix B2.

3.3 SOIL DESCRIPTIONS

Many of the thirty sampling locations showed evidence of past disturbance or soil mixing, with ill-defined horizons and occasional debris (e.g., brick pieces, gravel, glass shards), especially evident in the shallow sampling interval. This was somewhat expected because of the long history of urban use in the area. Generally, soils were described as either silt loam or silty clay loam, with a few exceptions of silty clay. Most samples ranged from medium gray to dark brown in color and some were mottled with black or red. Overall, soils were consistent with the types expected for soils in the target associations. USDA soil descriptions of the undisturbed cores samples (Table 2) compare with soil descriptions found in the County Soil Survey (Appendix A).

3.4 DRILLING AND SAMPLING

Boring logs and chain of custody forms for sampling are provided in Appendices B3 and B4, respectively. A CME-55 Drill rig was used for the study. Soil samples for chemical analyses were collected using a ¾-inch Hollow Stem Auger with a 3 ¼-inch Inner Barrel Sampler. Geotechnical samples were collected using a 3-inch Shelby tube.

A total of 24 borings were drilled successfully and sampled. There were eight borings from each of the three soil associations. Samples were collected for TAL metals, pH, and TOC analyses in each of the sampling intervals, 0-12, 24-36, and 48-60 inches below ground surface (bgs). Samples were collected for PAHs, only in the 0-12 inch sampling interval. Samples for CEC analysis were collected at all three sampling intervals, but only in half of the borings. Hexavalent chromium analysis was requested in 10 percent of the samples.

Samples were collected from the inner barrel sampler. The soil core was divided into the respective intervals and each interval was placed in separate pans. The soil was then homogenized and aliquots jarred for analyses. PAHs were collected prior to homogenization, in the surface sample core. Surface soil samples for TOC analyses were collected adjacent to the boring using a small hand augering device to assure adequate sample volume.

Shelby tubes for geotechnical analyses, including sieve analyses/hydrometer for texture and USDA classification, moisture content, and bulk density, were collected at two sampling intervals (0-36 and 36-72 inches bgs) in half of the borings.

3.5 QUALITY CONTROL AND ASSURANCE

Quality control samples, field replicate samples and MS/MSDs, were collected to meet or exceed the rates recommended in the work plan.

Decontamination procedures were limited. Since the sample never came in contact with the auger, the auger was not contaminated. Soil was removed from the auger with a shovel and brush and the auger was not power washed. The inner barrel sampler and sampling tools were decontaminated with an alconox wash and a de-ionized water rinse.

Oversight for health and safety issues and for drilling and sampling procedures are documented in the quality assurance forms provided in Appendix B5.

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4.0 DATA QUALITY EVALUATION

4.1 INTRODUCTION

Data were evaluated according to USACE and USEPA guidance documents (USACE, 1994, 1997, and 1999; USEPA 1996), as described in the work plan. The following summarizes the data quality evaluations for metals and PAHs, with accompanying tables provided in Appendix C.

All soil samples were analyzed for metals by EPA Method 6010B. If, during the analysis, arsenic or selenium were found at levels below the quantitation limit (QL), the sample was analyzed again using the more sensitive EPA Method 6020A. Only surface soil samples were analyzed for polynuclear aromatic hydrocarbons (PAHs) by EPA Method 8270C SIM.

The following quality control elements were inspected during the evaluation:

- Holding Time
- Matrix Spike (MS)
- Matrix Spike Duplicate (MSD)
- Matrix Duplicate (in absence of MSD)
- Method Blank (MB)
- Laboratory Control Sample (LCS)
- Laboratory Control Sample Duplicate (LCSD)

None of the samples exceeded holding times.

4.2 METALS

4.2.1 Matrix Spikes

For samples qualified as 'J', EPA Method 6020A matrix spikes did not result in meaningful recoveries due to the low level of spike added compared to the amount of analyte already in the sample. With no corrective action for this, 'R' would normally be assigned to the corresponding data. However, the matrix recoveries were acceptable in Method 6010B for the same corresponding samples. Unfortunately, these sample results were already qualified with 'J' since the results fell below the quantitation limit (QL). Even though the results did not fall below the QL for EPA Method 6020A, the results were still qualified since the matrix spike recoveries were not usable. The qualifier 'J', as opposed to 'R', was applied since the results between the two methods were comparable and at least one of the methods did not indicate matrix effects.

4.2.2 Matrix Spike Duplicates
Rationale applied for matrix spike duplicate is exactly the same as for matrix spike. The purpose of the matrix spike duplicate is to measure the precision of recovery for the analyte spiked into the soil. The unusable MSD recovery in EPA Method 6020A also resulted in an unusable precision measurement, the relative percent difference (RPD). As before, the MSD and RPD were unusable for EPA Method 6020A and consideration was given to the success of the MSD recoveries and RPD found from EPA Method 6010B.

4.2.3 Laboratory Control Samples
The laboratory control sample results for both methods in all batches were acceptable.

4.2.4 Method Blanks
Method blanks were uncontaminated.

4.2.5 Data Usability
Data were qualified according to strict application of the guidance. However, since these results are used in statistical applications for background studies, the actual reliability of the qualified metals was inferred by observing where these concentrations fell within the range of the entire dataset. In other words, if data preliminarily qualified with 'R' fell within the range of detected concentrations and did not represent outliers, then the data were considered as 'J' qualified and used in the statistical evaluations.

There are some difficulties in applying quality control measures designed for contaminants and/or trace amounts of naturally occurring substances to naturally occurring substances that are present in high concentrations, i.e., to the major elements in soil. Due to a number of field and laboratory-related factors, the applicability and interpretation of MS/MSD results for soils is one such difficulty. Both USACE and USEPA guidances indicate that MS/MSD are not appropriate for high-concentration metals (i.e., major elements) in soils. USACE (2001; App. I, Sec. 10.2.3.1) indicates that it is not necessary to perform matrix spikes for Al, Ca, Na, K, Mg, Fe, Mn in soil since "the native concentrations of these low-toxicity metals are relatively high". USEPA (1996; Ch. 1, Sec. 4.4.3) indicates that when the concentration of an analyte in the sample is greater than 0.1% (1000 mg/kg), spiking is not necessary. These guidances recognize that spike recovery studies are considered inappropriate for elements present at concentrations greater than 1000 mg/kg.

Among the factors affecting MS/MSD are the small analytical aliquot size and the nature of the material. The sample aliquot for soil analysis by ICP is only 1.25 grams. Due to the inherent heterogeneity of geologic materials, a 1.25-gram aliquot may not be representative of an 8-oz. jar sample, and may be quite different from other aliquots taken from the same jar. The field homogenization procedure conducted during sampling decreases compositional variability, but does not completely eliminate it. To eliminate heterogeneity requires laboratory preparation in which the soil is dried and pulverized to a 200-mesh prior to taking the analytical aliquot. This extensive sample preparation is not typically conducted on environmental samples. Therefore, the aliquots taken for MS/MSD have an associated degree of uncertainty.

Spiking analytes that occur at high levels in the matrix has associated analytical difficulties. To be useful, the spike must be resolvable from background. In the case of major elements present at percent-range concentrations, a spike that is high enough to be resolved from the native concentration will exceed the linear range of the instrument, requiring that analysis be performed at dilution. Since ICP is a multi-element method, dilution to bring high-concentration analytes into range may affect quantitation of low-concentration analytes. High concentrations may also affect the functioning of the analytical instrument and cause cross-contamination of other samples.

MS/MSD results were reported for major elements because the same stock spiking solution was used for both the LCS and MS/MSD (USACE laboratory validation requirement). Results outside criteria indicate a possible matrix effect and were coded 'J'. These data were determined usable for the purposes of the study, which is to characterize background ranges for a number of metals.

4.2.6 Hexavalent Chromium

Hexavalent chromium (Cr^{+6}) is an oxidized species that can readily be reduced to trivalent chromium (Cr^{+3}) under normal soil pH and redox conditions by soil components such as organic matter, ferrous iron, and sulfide. For this reason, low to zero percent recoveries for MS/MSD do not indicate a method QC failure, and are acceptable under the method QC criteria.

The laboratory ran 3 MS/MSD per batch for a total of 9, a rate of 33% (only 10% is normally required). The additional QC was requested since soil chemistry changes with depth and with soil type.

Of the 9 MS/MSD runs, 4 MS/MSD had 0% recoveries, 3 MS/MSD had low recoveries in the range 3.6-49.7%, and 2 MS/MSD had recoveries in the range 75-76.6% (which are within the standard acceptance criteria of 75-125% for total metals).

The zero and low percent recoveries likely mean that the soils are reducing in nature, and do not support the presence of Cr^{+6}; therefore, total Cr in these soils is Cr^{+3}. All MS/MSD from the 0-12 inch bgs sampling interval (and also some from deeper intervals) had zero percent recoveries. The surface soil interval typically contains the greatest amount of organic matter, which is probably the primary natural reductant for Cr^{+6}.

MS/MSD recoveries from the 24-36 and 48-60 inch sampling intervals ranged from 0% to 76.6%, indicating that the soils in general have a high reducing capacity that is not favorable to Cr^{+6}. Again, total Cr in these soils is Cr^{+3}.

4.3 POLYNUCLEAR AROMATIC HYDROCARBONS

4.3.1 Matrix Spikes

Most of the PAH analytes did not meet matrix spike criteria in batch 1222. (See Appendix C for complete list.) Corrective actions were performed on these analytes resulting in matrix spike recoveries within criteria except for benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, fluoranthene, chrysene, and pyrene. These compounds were qualified with a 'J'. Phenanthrene was underspiked in both spike attempts, hence the corrective action was inappropriate; however, due to the high amount contained in the sample, a high spike amount would have been difficult to achieve, therefore this analyte was also 'J' qualified. There were no MS/MSD results for sample 22 KCB 0-12". All results in this sample were preliminarily qualified as 'R'.

4.3.2 Method Blanks

Method blanks were free of contamination.

4.3.3 Surrogate Recoveries

All surrogate recoveries were within criteria.

4.3.4 Laboratory Control Samples

Recoveries for LCS were within criteria; however, the RPD between the LCS and LCSD in batch 1223 was 31.51% and 33.85% for fluoranthene and pyrene, respectively. The criterion is 30%. The LCSD is not a requirement for this analytical method; however, since this QC was reported and was outside criteria, a qualifier was assigned. Since the guidance does not address this element, there is no requirement to reject the data. A 'J' qualifier therefore was assigned to these chemicals in samples 1KSU 0-12", its duplicate 1AKSU 0-12", and 20 SMO 0-12".

4.3. 5 Data Usability

As with the metals data, organic data were qualified according to strict application of the guidance. However, as with metals data, the actual reliability of the qualified data may be inferred by observing where these concentrations fall within the entire dataset. The 'R' qualifier was assigned to data in 22 KCB 0-12" since there were no MS/MSD for this sample. However, this is considered a contractual problem and not necessarily a technical problem. Other MS/MSD indicated that the analytical system was working for other samples analyzed from similar matrices. Since results for this sample fell within the ranges of detected concentrations from other samples, the data were considered as 'J' qualified and used in the statistical applications.

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5.0 ANALYTICAL RESULTS

5.1 METALS

Metals were analyzed using EPA Method 6010. Arsenic and selenium were analyzed twice in many of the soil samples, the second time using EPA Method 6020. Hexavalent chromium was analyzed by EPA Method 3060A/7196A. Table 3 presents the qualified, analytical results expressed in mailgrams per kilogram (mg/kg or parts per million). Replicate sample results were averaged with this value presented in Table 3. Note that for nondetects, the table shows the surrogate value used in the statistical evaluations, which was a concentration at half the method detection limit.

The range of detected concentrations and the frequencies of detection (FODs) are shown in the statistical summary tables found in Appendix D. Sets of summary tables are presented in the appendix, arranged by the various data groups evaluated (i.e., by soil association, by sampling depth, by sampling depth within each association, and grouped by all samples combined). These populations are discussed later in Section 6. The population sizes shown in the appendix tables are after outliers have been removed to achieve either a normal or lognormal distribution.

Aluminum, arsenic, barium, calcium, cobalt, copper, lead, magnesium, manganese, sodium and zinc were detected in all 72 samples. Chromium VI and silver were not detected in any of the samples. Metals found in less than 50 percent of the samples are considered nonparametric and included antimony, selenium, and thallium. While mercury was nonparametric in the KCB and KSU soils associations, it was detected at 75 percent in SMO soils.

5.2 POLYNUCLEAR AROMATIC HYDROCARBONS

PAHs were analyzed in 24 surface soil samples, following USEPA Method 8270C - selective ion method (SIM). Table 4 presents the analytical results. The range of detected concentrations and FODs are shown in the statistical summary tables in Appendix E.

All PAHs were detected in some samples. Acenaphthylene was detected in only one sample; acenaphthene, anthracene, fluorene, and naphthalene were detected in less than 50 percent of the samples. These PAHs represent nonparametric distributions. The remaining PAHs were detected in greater than 79% of the surface soil samples and included: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,I)perylene, benzo(k)fluoranthene, dibenz(a,h)anthracene, fluoranthene, indeno(1,23-c,d)pyrene, phenanthrene, and pyrene.

The PAH concentrations are expressed as ng/kg (nanograms per kilogram) in the data summaries. The range of concentrations for benzo(a)pyrene, as an example, was 1,675 to 464,348 ng/kg. Converted to micrograms per kilogram, or parts per billion, this range would be 1.675 to 464.348 ug/kg or ppb.

Although not in the work plan, the laboratory analyzed 7 subsurface soil samples for PAHs. The results are provided in Appendix E for information purposes and are not included in the background calculations discussed Section 6. Phenanthrene was found in all of the subsurface samples; however, most PAHs were not detected or detected at low frequencies. Generally, if detected in the subsurface soils, PAHs were at lower concentrations than found at the surface.

5.3 OTHER CHEMICAL ANALYSES

5.3.1 pH

Soil pH was determined in the laboratory for all 72 samples, following EPA Method 9045C. Table 5 summarizes the results. The pH of all soils ranged from a minimum of 5.28 to a maximum of 8.44. Averages for all soils, calculated for each sampling interval within each soil association, were 6.01 to 6.84, with no discernible trends by interval or by association.

5.3.2 Cation Exchange Capacity

CEC was determined in half of the samples collected, using by EPA Method 9081C. Table 6 summarizes the results. CEC for KCB, KSU, and SMO soils averaged 16.1, 14.5, and 18.9, respectively. CEC is the capacity of cations on soil to interchange with cations in soil solution. The unit of milliequivalents per 100 grams of soil represents the electrical charge of the soil that can attract cations. Clay and organic matter usually provide most of the exchange sites in soil.

5.3.3 Total Organic Carbon

TOC was analyzed using ASTM Method D2974 in samples collected at two intervals within each of the 24 borings, for a total of 48 analyses. TOC is expressed as mg/kg and often converted to a unitless fraction organic carbon (FOC) or expressed as a percent. Organic carbon contents in soils are expressed as percents in Table 7. Shallow samples (0-12 in bgs) ranged from a minimum FOC of 0.0011 to a maximum of 0.0116. The averages for KCB, KSU, SMO were 0.0043, 0.0032, and 0.0054, respectively. Samples collected from 24 to 36 in bgs ranged in carbon content from 0.002 to 0.0092, with averages for KSB, KSU, and SMO at 0.0055, 0.0045, and 0.0044, respectively. Samples from 46 to 60 in bgs ranged from 0.0008 to 0.0123, and averages for KSB, KSU, and SMO were 0.0049, 0.0037, and 0.0057, respectively. The TOC results for surface soils were lower than expected, since concentrations tend to be higher at the surface and then decrease with depth. The similarity in organic carbon content across depths supports the idea that soils in the areas sampled may have been previously disturbed.

5.4 GEOTECHNICAL ANALYSES

5.4.1 Dry Bulk Density/Moisture Content

Shelby tube samples were taken at two depths in 12 borings and submitted for bulk density analyses following ASTM Method D2937. Moisture content was determined using ATSM Method D2216. Table 8 summarizes the results by sample and by soils associations. Measured bulk densities ranged from 1.583 to 1.699 grams per cubic centimeter. Bulk densities at 36-60 in bgs were slightly greater than those measured from 0-36 in bgs in all three soil associations.

5.4.2 Sieve Analysis/Soils Classification

Sieve analysis, by ASTM Method D422, was performed on the 24 Shelby tube samples submitted. Hydrometer tests were determined by the geotechnical laboratory to not be necessary, based on the clay content of the soils. USDA soil classifications were determined. Table 2, referenced in Section 4, provides descriptions and the classifications for the soil samples.

* * *

6.0 STATISTICAL EVALUATION

6.1 METHOD

The methodology used to determine background concentrations follows recommendations from the following USEPA publications: *Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites* (1995a), *Establishing Background Levels* (1995b), *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance and its Addendum* (1989b and 1992b), *Final Guidance for Characterizing Background Chemicals in Soil at CERCLA Sites* (2002), and other publications (MI, 1994; Hardin & Gilbert, 1993; Singh, 1994 and 1999).

As discussed in Section 2.3, a 95 percent upper tolerance limit (UTL) is a commonly used statistical approach for determining chemical background concentrations. This statistical technique establishes an upper limit on a distribution of concentrations, which then represents the maximum concentration considered to be from the distribution. If data from an environmental site is compared and found to be greater than the upper bound of the distribution, the data is considered to be above background and likely site-related.

As with many statistical tests, the 95% UTL is only valid for populations that are parametric with normal or lognormal distributions. Therefore, the first step in determining background was to determine population distributions. Datasets not testing normal or lognormal are nonparametric and their statistical treatment is described later.

6.1.1 Frequency of Detection and Censored Data

Prior to testing distributions for the various populations, each chemical-specific dataset was reviewed to determine whether it was "censored". Censored data refers to nondetect results for some of the samples within the population being evaluated (Gilbert, 1987). Treatment of censored data followed USEPA recommendations (1989 and 2002):

If less than 15% of the data were censored (i.e., nondetect), then the nondetect observations were assigned a surrogate value of half the method detection limit prior to testing the distribution for normality or lognormality.

If greater than 15% but less than 50% of the observations in a population were nondetect, a value of half the method detection limit was assigned the nondetects. Then the distribution of the "detects only" data and the "censored and detects" data (i.e., all observations) were both tested for normality and lognormality.

If greater than 50% of the observations in a population were censored, then the population was assumed to be nonparametric and treated as described in Section 6.1.5.

6.1.2 Distribution Tests

Depending on the size of the dataset, two techniques were employed. For datasets with less than 50 samples, the Shapiro Wilk W test was used. The calculation for the W test is:

$$W = \frac{1}{d}[\sum_{i=1}^{k} a_i (x_{n+1} - x_i)]^2$$

and:

$$d = \sum_{i=1}^{n} (x_i - \bar{x})^2$$

$k = n/2$ *if n is even,* $k = (n-1)/2$ *if n is odd*

and:

n	=	the number of samples in the dataset
x	=	the mean of the data set
a_i	=	coefficients a1, a2,...ak from table (Gilbert, 1987)

The resulting W is compared to a tabulated value of $W_{0.05}$ for n samples. For a calculated value of W greater than the tabulated value, the data are assumed to be normal. Calculated values of W less than the tabulated values indicate that the data are not normally distributed. If not, then the Shapiro Wilk W test is used on the log-transformed data to determine whether the data follow a lognormal distribution.

For datasets larger than 50 (for this project, all metals data combined for a chemical-specific population size of n=72), the Lilliefors test was used. The Lilliefors Test is a modification to the Kolmogorov-Smirnov (K-S) test for normality (USEPA, 2000). The K-S test is based on the maximum difference between the cumulative distribution of the dataset and a hypothesized normal cumulative distribution. If the difference is significant as compared to the tabulated critical value, then the data is not normal. While the K-S test assumes the mean and standard deviation of the normal distribution are known prior to testing, the Lilliefors modification accounts for what is usually the case, i.e., that the mean and standard deviation are not known prior to testing and must instead be estimated from the data. If the data do not test normal using the Lilliefors test, it is reapplied on log-transformed data to determine whether the data follow a lognormal distribution.

The USEPA software program ProUCL Version 2.1, released by Lockheed Martin Environmental Services, is designed to determine 95% upper confidence limits (UCLs) for risk assessment calculations, but also includes algorithms for the Shapiro Wilk and Lilliefors distribution tests. The software was used to perform the Lilliefors test and to confirm the Shapiro Wilk W results.

6.1.3 Outlier Treatment

Some populations did not test normal or lognormal. In these instances, outlier tests were applied, and if confirmed, the outliers were removed from the dataset and the distribution retested. Outliers are defined as "an observation that does not conform to the pattern established by other observations" (Hunt, 1981). Outliers can be one or more of either the minimum or maximum chemical concentrations detected.

Several statistical treatment options for outliers were applied. The Discordance Outlier Test is considered a standard practice by ASTM (1994) and cited in several USEPA guidances (1989b, 1992b, and 2000). The procedure is described in the following manner:

1. Observations are ordered and denoted by $x_1 \ldots x_n$, with x_n assigned to the largest observation.

2. Mean (x), and standard deviation (s) are calculated for the data.

3. The statistic T_n is determined by:

$$T_n = (x_n - x)/s$$

4. T_n is then compared to the tabulated critical value given for the sample size, and if T_n exceeds the 5% critical value for population size n, then this is evidence that x_n is a statistical outlier.

Another standardized practice for testing outliers was applied (ASTM, 1984; Grubbs, 1969). This test evaluates the two maximum or two minimum detections at once to determine if both are outliers and masking each other. This procedure is based on the ratio of the sum of the squares. For testing the two maximum values as outliers, the sum of squares is determined with the two maximum values omitted, and then the sum of squares is determined including the two values. This ratio is then compared to a tabulated lower 5% significance level for the population size n. If the ratio is less than the critical value, it is significant and indicates outliers. The procedure is performed in a similar way for testing the two minimum values.

The Studentized Range Test was the third outlier test used for some populations (ASTM, 1984; USEPA, 2000). This test compares the range of the concentrations detected to the standard deviation, with the ratio, w/s, then compared to tabulated critical values:

$$w/s = (x_n - x_1)/s$$

The most basic and reliable tool used to determine outliers was visual inspection of the plotted data. The USEPA Pro-UCL Software provides quantile-quantile (Q-Q) plots, which displays the entire distribution of data, ranging from the lowest to highest value. The vertical axis is the measured concentration, and the horizontal axis, in this application, is the percentile of the theoretical normal distribution. This Q-Q plot is also known as a normal probability plot (USEPA, 2000 and 2002). If the data follow a normal distribution, the plot forms a straight line with a slope of one, regardless of the selected scales. The scales for the concentration axes may be either both linear or both logarithmic, for testing normal or lognormal distributions. Data points deviating from the line represent outliers.

6.1.4 95 % UTL

The upper tolerance limit (UTL) was calculated using the following equation:

$$UTL = x + Ks$$

where:
x is the mean
S is the standard deviation
K is the tolerance factor based on population size (n), confidence, and coverage.

USEPA (1989c) recommends using tolerance factors for a 95% confidence and 95% coverage. This means that one is 95% confident that at least 95% of data points (in this case, background chemical concentrations) will be less than the UTL value. Tables of K values calculated for varying levels of confidence and coverage have been published (Lieberman, 1958; Guttman, 1970).

For datasets that are small, the lognormal 95% UTL may not be robust. Therefore, if the 95% UTL was greater than four times the median of the background distribution, four times the median was considered representative of background. This check on reasonableness of a lognormal UTL has been used by Washington State Department of Ecology, as described by Hardin and Gilbert (1993).

For censored data sets, where both the "censored and detects" data and the "detects only" data tested either normal or lognormal, the correlation coefficient (r) of the plots for the "censored and detects" data and for the "detects only" data were calculated and compared. If the value of r was greater for the "censored and detects" data plot, then the Cohen's Adjustment (USEPA, 1992b) was applied to correct the mean and standard deviation before calculating the 95% UTL. If the value of r is greater for the "detects only" data plot, then the Aitchison's Adjustment (USEPA, 1992b) to the mean and standard deviation was made.

6.1.5 Nonparametric Upper Bound

For data sets that were neither normal nor lognormal, and for data sets that had greater than 50% nondetects, the upper bound was assumed equal to the maximum detected concentration (Guttman, 1970).

6.2 POPULATION (N) DISTRIBUTIONS

The design of the study allowed for the metals data to be tested for normal or lognormal distributions grouped a number of ways. The data were tested in the following groups: sampling intervals within soil associations (i.e., 9 datasets of n=8 samples for each metal); soil associations (3 datasets of n=24 samples for each metal); and sampling intervals (3 datasets of n=24 samples for each metal). The fourth group tested was all data combined to see if all samples come from the same population (i.e., 1 dataset of n=72 samples for each metal).

All metals datasets were treated as described in Section 6.1. Appendix D presents the statistical evaluations with subdivisions (i.e., D1, D2, D3, and D4) for each group listed above. Each sub-appendix contains the statistical summary tables and Q-Q plots showing distributions and outliers.

Table 9 shows which of the metals results were identified as outliers and removed from any of the datasets. Since outliers were not consistently from the same sample, none of the samples were considered contaminated or excluded from the background evaluation. If outliers existed, in most cases less than 10 percent of the samples within a dataset were removed to achieve normal or lognormal distributions. In a few cases (e.g., calcium, sodium), it was necessary to remove up to 30 percent of samples to achieve normal or lognormal distributions. The exact number of outliers removed for any population can be determined from the column "samples in distribution" given in the appendix summary tables.

Tables 10, 11, and 12 compare the distributions for the various datasets tested. Table 10 shows the distributions of association sampling intervals (n=8) compared to the distributions of the soil associations (n=24). Table 11 shows the distributions of association sampling intervals (n=8) this time compared to the distributions of the sampling intervals (n=24). Table 12 shows the distributions of the soils associations and the sampling intervals (each n=24) compared to the distributions for all data combined (n=72).

For PAHs, the 24 surface soil samples were assumed to represent one population, since atmospheric deposition is ubiquitous. Appendix E presents the statistical summary tables and Q-Q plots showing distributions and outliers. (Note that the appendix also includes the additional subsurface soil analytical results provided by the lab, for information purposes, since this data is not summarized elsewhere in the report.)

6.3 RESULTS

6.3.1 Metals Background Determined by Association Sampling Interval (n=8)

Metals grouped by sampling intervals within each soil association tested normal, lognormal, or both, with a few exceptions. Antimony and selenium were consistently nonparametric because of the low frequencies of detection (FOD), and mercury and thallium in some populations. When detected between 50-85%, the better distribution for mercury and thallium was usually the 'detects only' data. Most distributions were achieved without outlier removal. With the exception of thallium in KSU 0-12", it was only necessary to remove one outlier to achieve either normal or lognormal distributions. Hexavalent chromium and silver were not detected in any of the samples. Statistical results are in Appendix D1 with Table 13 summarizing background levels for the tested populations.

6.3.2 Metals Background Determined by Associations (n=24)

Metals in the KCB soil association tested normal, lognormal, or both (N/L), with the exceptions of antimony, mercury, selenium, and thallium with low FOD. Sodium required removal of the 7 outliers (29% of the data) to achieve a lognormal distribution.

Metals in the KSU soil association tested normal and/or lognormal, with the exceptions of antimony, mercury, and selenium with low FOD. Thallium tested N/L with the nondetects (or censored data) removed.

Metals in the SMO soil association tested normal and/or lognormal, with the exceptions of antimony, selenium, and thallium with low FOD. Mercury tested normal with the censored data removed. Calcium required removal of 25% of the data to achieve a lognormal distribution.

Statistical results are shown in Appendix D2 and Table 14 summarizes background levels for metals within the 3 soil associations.

6.3.3 Metals Background Determined by Sampling Interval (n=24)

Metals in the 0-12 inch sampling interval tested normal and/or lognormal with the exceptions of antimony and selenium with low FOD. Distributions presented for mercury and thallium are with censored data removed.

Metals in the 24-36 inch sampling interval tested normal and/or lognormal with the exceptions of antimony, selenium, and thallium with low FOD. Mercury was N/L using 'detects only' data.

Metals in the 48-60 inch sampling interval tested normal and/or lognormal with the exceptions of antimony, mercury, and selenium with low FOD. Thallium tested N/L by using the 'detects only' data.

Statistical results are in Appendix D3 and Table 15 summarizes background levels for metals within the 3 sampling intervals.

6.3.4 Metals Background Determined Using All Samples Combined

Metals for all samples combined tested normal and/or lognormal with the exceptions of antimony, selenium, and thallium with low FOD. Mercury tested lognormal based on 'detects only' data.

Statistical results are in Appendix D4 and Table 16 summarizes metals background levels determined using all samples combined.

6.3.5 PAH Background (n=24)

PAHs tested lognormal with the exceptions of acenaphthene, acenaphthylene, anthracene, fluorene, and naphthalene because of low FOD. Benzo(a)anthracene, benzo(g,h,i)perylene, dibenz(a,h)anthracene, fluoranthene, and indeno(1,2,3-cd)pyrene were lognormal with the censored data removed. None of the PAHs tested normal which may be due, in part, to sample location relative to atmospheric source or to the impact of terrain on deposition.

Appendix E provides the statistical results and Table 17 summarizes the background levels.

6.4 RECOMMENDED BACKGROUND LEVELS

6.4.1 Metals

Table 18 summarizes the recommended background concentrations for metals in the Blue Valley Industrial Corridor. The recommended background concentrations are the maximum calculated background concentrations for any of the populations evaluated. Note that the maximum detected concentration was the recommended background value only when the dataset was nonparametric. Also, while 4 times the median was the recommended value for some metals datasets, none of the maximum background levels shown are based on 4 times the median. Therefore, the recommended background levels for soils in the Blue Valley Industrial Corridor, except for metals that have nonparametric distributions, is the high-end of the range of calculated 95% UTL values. This is reasonable for sites located in fill areas in the floodplain or areas where the terrain has been substantially altered, since in either case, it is possible for soil to represent a mixture of any of the populations evaluated. It is not recommended to simply use the calculated 95% UTL for 'all samples combined' (n=72) because the 95% UTL for other populations, in instances, are greater.

6.4.2 PAHs

The recommended background concentrations for PAHs in surface soil in the Blue Valley Industrial Corridor are shown in Table 17.

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7.0 SUMMARY AND APPLICATIONS

7.1 STUDY SUMMARY

The native soils in the Renewal Project area were sampled and background determined for various sample populations: KCB, KSU, and SMO soil associations; 0-12, 24-36 and 46-60 inch sampling intervals; and for the three sampling intervals within each of the three soil associations; and for all soil samples combined. Any of these soil populations (i.e., soil mixtures) could exist in the Renewal Project Area as a result of historical regrading or cut and fill operations.

The 95% upper tolerance limit (UTL) approach is one of the options provided in the USEPA background guidance document, which was recently finalized (2002). An upper bound or 95% UTL of concentrations that could reasonably be considered background was determined for each metal, within each sampling population.

Background for populations testing normal or lognormal was the 95% UTL, unless the 95% UTL for a metal exceeded its maximum detected concentration. If this occurred, the 95% UTL was compared to 4 times the median concentration and the smaller of these two values was used. This provides a conservative check on the reasonableness of the calculated UTL (Hardin and Gilbert, 1993). Background for each population not testing normal or lognormal (i.e., nonparametric) was the maximum detected concentration. Antimony and selenium were nonparametric in all populations evaluated, while mercury and thallium were nonparametric in some. Hexavalent chromium and silver were not detected in any of the samples.

The calculated background levels for each metal were compiled and considered to 'bracket' possible combinations of mixed, native soils in the area. Thus the upper-end of the range is the reasonable, maximum background level recommended for use.

Other soil properties were characterized including: pH, total organic carbon, cation exchange capacity, dry bulk density, and classification. This information was compiled based on sampling intervals within each of the three soil associations. The purpose of this information was twofold, for confirming soil sample groupings and, to a limited extent, for use in environmental studies.

7.2 APPLICATIONS

The calculated background levels for PAHs and metals in soil (Tables 16 and 17) are intended for use in environmental studies conducted in the Blue Valley Industrial Urban Renewal Project area. The pH, CEC, and TOC information compiled in Tables 5 through 7 and, to a limited extent, the bulk densities compiled in Table 8 are available for use. Soils located in the flood plain or in areas of mostly fill may exhibit different physical properties. Confirmation sampling for similarity may be required.

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TABLES

Table 1
Locations Sampled
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Number	Soil	Address
1*	KSU	ROW (Indiana and Linwood)
2	SMO	ROW (W of Van Brunt, near 32nd)
3	SMO	4701 E. Linwood Blvd. (Linwood Park)
4*	KSU	Oak Park
7	SMO	4201 E. 38th St (Seven Oaks Park)
8	KSU	3730 Vineyard Rd
9	KSU	5231 E 39th St
10	KSU	4108 Jackson (Cleveland Park)
11	SMO	4108 Jackson (Cleveland Park)
12	SMO	4250 Van Brunt Blvd. (Vineyard Park)
14	SMO	ROW (E of Van Brunt, N of Clary)
15	KCB	ROW (W of Van Brunt, S of 45th)
17	KSU	ROW (W of Elmwood, S of school)
19	KCB	2901 E Emanuel Cleaver II Blvd
20*	SMO	Brooklyn Park
21	KCB	4725 Coal Mine Rd.
22	KCB	Coal Mine Rd. (Municipal Farm)
24	KCB	5518 Hardesty
25	KSU	ROW (S of 55th, near Myrtle)
26	KSU	ROW (W of Elmwood, S of 56th Ter.)
27	SMO	4020 E. 58th St.
28	KCB	6700 Zoo Dr. (Swope Park)
29	KCB	6700 Zoo Dr. (Swope Park)
30	KCB	6700 Zoo Dr. (Swope Park)

Notes:
Locations are shown on Plate 1.
Asterisks indicate work plan locations that were moved (with KC approval) due to field difficulties.
A total of 24 locations were sampled, eight from each soil association.
Skipped sequential numbers indicate an alternative sampling location that was not selected.

Soil Assocations
KCB = Keenebec-Colo-Bremer
KSU = Knox -Sibley-Urban
SMO = Sibley-Menfro-Oska

Table 2
Soils Descriptions and Classifications
Blue Valley Soils Background Study Report
Brownfields Showcase Project

ID	Assoc.	Unit	Description & USDA Soil Classification (0-36 in bgs)	Description & USDA Soil Classification (36-60 in bgs)
15	KCB	36	Dark brown SILT LOAM with trace of organics	Dark brown SILTY CLAY LOAM with organics
19	KCB	36	Brown SILT LOAM with trace of organics	Dark brown SILT LOAM with trace of organics
21	KCB	30		
22	KCB	38	Brown-mottled gray-speckled black & reddish brown SILTY CLAY LOAM	Brown-mottled grayish brown speckled reddish brown & black SILTY CLAY LOAM
24	KCB	36	Dark brown SILTY CLAY LOAM with organics	Brown-mottled gray-speckled reddish brown SILTY CLAY LOAM w/trace of organics
28	KCB	36		
29	KCB	36		
30	KCB	36	Dark brown SILTY CLAY LOAM	Dark brown SILTY CLAY
1	KSU	61D		
4	KSU	60C	Brown-speckled reddish brown SILTY CLAY w/iron stains	Olive brown-spotted white CLAY w/weathered shale
8	KSU	61D	Brown-spotted black SILTY CLAY LOAM w/trace of organics	Brown-mottled reddish brown spotted black SILTY CLAY LOAM w/iron stains
9	KSU	61C		
10	KSU	60C	Brown-speckled black SILTY CLAY LOAM w/organics	Dark brown SILTY CLAY LOAM with organics
17	KSU	60C	Brown SILTY CLAY with organics	Brown-mottled reddish brown SILT LOAM w/organics
25	KSU	60C		
26	KSU	60C		
2	SMO	65F	Brown-speckled black SILTY CLAY LOAM w/trace of organics	Brown-mottled olive brown spotted white CLAY LOAM w/trace of caliche
3	SMO	65F	Brown-spotted gray-speckled reddish brown SILTY CLAY LOAM w/organics & iron stains	Dark brown SILT LOAM
7	SMO	65F		
11	SMO	65F	Brown-speckled black & reddish brown SILTY CLAY LOAM w/iron stains	Well graded GRAVEL with clay & sand (USDA class material)
12	SMO	65F		
14	SMO	65F	Reddish brown SILTY CLAY LOAM w/organics	Reddish brown-speckled black SILTY CLAY LOAM
20	SMO	65F		
27	SMO	65F		

Notes:
USDA Classifications are shown capitalized.
Sampling locations are shown on Plate 1.
Two intervals at half of the sampling locations were submitted for sieve analysis (ASTM D422).

Soil Associations
KCB = Keenebec-Colo-Bremer
KSU = Knox -Sibley-Urban
SMO = Sibley-Menfro-Oska

Soil Map Units
30 = Kennebec Silt Loam
36 = Bremer Silt Loam
38 = Wiota Silt Loam
60C = Sibley Urban (5-9% slope)
61C = Knox Urban (5-9% slope)
61D = Knox Urban (9-14% slope)
65F = Snead Urban (9-30% slope)

Table 3
Metals Results (mg/kg)
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium
15 KCB 0-12	8179	*0.97* U	4.7 J	206	0.652	0.539	3671
15 KCB 24-36	8676	*1* U	4.5 J	184	0.652	0.607	3455
15 KCB 48-60	10.7 J	*0.945* U	5.19 J	5.18	*0.0235* U	*0.1405* U	924
19 KCB 0-12	6450	*1.045* U	12.3	164	0.543	0.956	3633
19 KCB 24-36	5700	*1.01* U	3.86 J	165	0.477 J	0.532	2998
19 KCB 48-60	5130	2.92 J	2.56 J	184	0.502	0.551	2850
21 KCB 0-12	7171	*0.97* U	4.84	142	0.6165	0.439 J	3928
21 KCB 24-36	12756	*0.965* U	12.75	192	0.7205	0.377 J	4186
21 KCB 48-60	6012	*0.93* U	3.73	155.5	0.5855 J	0.6	3206
22 KCB 0-12	12231 J	*0.975* U	10.6	147	0.743	0.457	3512
22 KCB 24-36	16336 J	2.63 J	5.4 J	199	1.19	0.788	4136
22 KCB 48-60	11652 J	*0.965* U	5.44 J	172	0.865	0.61	4154
24 KCB 0-12	5029	2.13 J	2.8	139	0.441 J	0.473 J	2166
24 KCB 24-36	7473	*0.965* U	4.62	122	0.616	0.365 J	3165
24 KCB 48-60	7620	*0.92* U	5.12	140	0.709	0.43 J	3704
28 KCB 0-12	12021 J	*0.94* U	4.13 J	139	0.934	6.16	31777
28 KCB 24-36	7229 J	*0.935* U	4.62 J	161	0.579	0.834	3510
28 KCB 48-60	13417 J	*0.975* U	7.58 J	256	0.95	0.424 J	5152
29 KCB 0-12	6889 J	*0.9875* U	3.79	170	0.635	0.583	3188
29 KCB 24-36	4303 J	*0.965* U	2.38 J	167	0.449 J	0.548	2169
29 KCB 48-60	4569 J	*0.97* U	2.69 J	117	0.449 J	0.315 J	2416
30 KCB 0-12	6169	*0.985* U	2.37	145	0.578	0.375 J	3221
30 KCB 24-36	7239	*0.95* U	4.54	135	0.663	0.366 J	3593
30 KCB 48-60	5740	*0.965* U	6.41	98.4	0.612	0.442 J	3424
1 KSU 0-12	5426	*2.7425* U	11.705	104.5	0.4315 J	1.154	46924
1 KSU 24-36	6304	*2.015* U	3.315	102.65	0.4035 J	*0.137* U	2616
1 KSU 48-60	5116	*1.005* U	3.905	100.55	0.368 J	*0.1375* U	2537
4 KSU 0-12	15481	*0.995* U	1.93	238	1.17	*0.302* U	6392
4 KSU 24-36	14681	*0.955* U	0.647	196	0.744 J	*0.293* U	11948
4 KSU 48-60	8930	*0.96* U	1.02	59.8	0.526	*0.139* U	32493
8 KSU 0-12	6729	*0.935* U	7.85	164	0.555	1.11	6100
8 KSU 24-36	7764	*0.99* U	6.26 J	115	0.691	0.365 J	3585
8 KSU 48-60	8919	*0.9075* U	6.24 J	168	0.838	0.474 J	3879
9 KSU 0-12	11898 J	*1.955* U	5.88 J	278	0.829	0.439 J	4832
9 KSU 24-36	8420 J	*0.94* U	5.12 J	259	0.754	0.694	4141
9 KSU 48-60	13383 J	*0.995* U	4.81 J	259	1.14	0.654	4273
10 KSU 0-12	11851	*0.91* U	8.77	216	0.734	0.48	3809
10 KSU 24-36	12477	*0.955* U	12.9	250	0.706	0.585	6665
10 KSU 48-60	14529	*0.945* U	8.94	261	0.83	0.478	4869
17 KSU 0-12	8748	*1.015* U	8.81 J	133	0.516	*0.144* U	3069
17 KSU 24-36	8922	*0.92* U	7.79 J	182	0.619	0.444 J	3305
17 KSU 48-60	9894	*0.925* U	5.69 J	96.4	0.653	0.476 J	3044
25 KSU 0-12	12658 J	*0.96* U	5.13	238	0.8965	0.4715	3967
25 KSU 24-36	17605 J	*1* U	7.78	278.5	0.9775	0.3775 J	3497
25 KSU 48-60	15768 J	*0.955* U	4.615	301	1.195	0.487 J	5890
26 KSU 0-12	9151	*0.955* U	6.3	166	0.595	0.741	5321
26 KSU 24-36	16000	1.93 J	9.65	252	0.859	0.527	3822
26 KSU 48-60	13809	*1.015* U	8.44	251	0.775	0.372 J	3655
2 SMO 0-12	11281	*1.015* U	4.97 J	198	1.02	0.359 J	4892
2 SMO 24-36	13271	*1.025* U	7.36 J	77.6 J	1.405 J	1.05 J	29854
2 SMO 48-60	11823	*1.035* U	4.01 J	70.3 J	1.165	0.758 J	62280
3 SMO 0-12	7960	*0.99* U	5.32 J	204	0.664	0.917	4969
3 SMO 24-36	7790	3.93 J	5.54 J	189	0.645	0.502	4113
3 SMO 48-60	9506	*0.89* U	10.6 J	160	0.616	0.331 J	3602
7 SMO 0-12	6588	*0.85* U	10.8	200	0.536	0.897	4361
7 SMO 24-36	16978	*5.05* U	13.6	210	0.937	0.474 J	3879
7 SMO 48-60	12960	*3.715* U	10.1	457	0.732	0.565	3568
11 SMO 0-12	15801	*0.945* U	18	202	0.909	0.574	3941
11 SMO 24-36	14121	2.5 J	7.94	341	1.24 J	4.41	15125
11 SMO 48-60	16735	*4.955* U	14.7	343	1.33	2.37	6684
12 SMO 0-12	16867	*1.885* U	6.14	373	1.2	0.735 J	4309
12 SMO 24-36	13238	*0.915* U	5.57	176	1.05	0.777 J	4139
12 SMO 48-60	10332	*0.96* U	4.99	237	0.925 J	0.937 J	5482
14 SMO 0-12	7154	*1.015* U	4.835 J	152.5	0.647	0.3295 J	2447
14 SMO 24-36	7333	*3.4475* U	4.51 J	109.65	0.6325	0.274 J	2225
14 SMO 48-60	9204	*0.985* U	12.2	111.25	0.826	*0.14* U	3091
20 SMO 0-12	5976	*1.01* U	12.3	95.8	0.388 J	*0.127* U	2510
20 SMO 24-36	8878	*1.995* U	8.05	139	0.843	*0.1435* U	37483
20 SMO 48-60	8473	*2.055* U	1.01	45.4	0.52	*0.138* U	20250
27 SMO 0-12	4175	*0.9325* U	11.2 J	191	0.462 J	11.6	172030
27 SMO 24-36	10377	*0.92* U	6.98 J	196	0.826	0.426 J	4774
27 SMO 48-60	11327	*1.005* U	6.74 J	189	0.82	0.323 J	4273

Notes: 'J' means concentration is estimated. 'U' means the analyte was not detected.
Underlined qualifiers were assigned during QC review.
Italics show concentrations at half the detection limit for 'U' qualified data.
Hexavalent chromium and silver were analyzed, but not detected in any samples.

Table 3
Metals Results (mg/kg)
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Sample ID	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
15 KCB 0-12	12.3	8.59	15.1	13405 J	14.2	1756	737
15 KCB 24-36	12.6	10.5	14.5	14008 J	15.7	1946	792
15 KCB 48-60	*0.2345* U	0.2345 U	*0.2345* U	*2.345* UJ	*1.17* U	90.6 J	1.12 J
19 KCB 0-12	10.7	8.82	14.7	13153 J	39.8	1694	740
19 KCB 24-36	9.14	8.51	11.2	11822 J	12.9	1633	692
19 KCB 48-60	8.45	8.37	12	10696 J	11.1	1549	932
21 KCB 0-12	10.2	8.81	11.7	11534 J	21.9	1510	527
21 KCB 24-36	16	11.8	19.4	22118 J	19.4	2818	588
21 KCB 48-60	8.12	7.17	10.4	17664 J	16.3	1676	663
22 KCB 0-12	18.1	10.8	19.4	20260 J	18.3	2874	646 J
22 KCB 24-36	22	17.1	21.3	25445 J	19	3567	1146 J
22 KCB 48-60	17.9	12.3	17.2	20587 J	15.4	3278	911 J
24 KCB 0-12	9.1	10.5	10	9538 J	14.9	1289	769
24 KCB 24-36	12.1	8.37	12.8	14127 J	15.4	1760	435
24 KCB 48-60	12	9.54	13	14374 J	14.6	2151	625
28 KCB 0-12	25.8	13.1	30.7	22108 J	37.2	3670	896 J
28 KCB 24-36	12.7	11.4	12.8	13048 J	15.1	1688	1101 J
28 KCB 48-60	19.3	15.6	21.3	23470 J	19.9	2814	817 J
29 KCB 0-12	11.7	9.56	13.1	12996 J	20.3	1862	785 J
29 KCB 24-36	7.74	7.08	9.46	8262 J	12.2	1187	613 J
29 KCB 48-60	7.4	7.01	9.13	9033 J	6.59	1300	524 J
30 KCB 0-12	10.9	8.8	14.8	12127 J	13.3 J	1705	748
30 KCB 24-36	13.5	8.77	14.7	14827 J	12.8	2052	363
30 KCB 48-60	10.6	8.14	11.5	11873 J	11.6	1754	593
1 KSU 0-12	7.82	5.9	12.5	11040 J	41.2	2269	382
1 KSU 24-36	8.52	5.84	8.19	9188 J	8.6 J	2049	401
1 KSU 48-60	6.66	5.7	8.2	8182 J	7.52 J	1862	450
4 KSU 0-12	26.1	10.7	14.2	27086 J	10.3 J	4775	793
4 KSU 24-36	29.3	11.7	8.98	24040 J	7.25 J	5864	351
4 KSU 48-60	18.5	9.63	19.4	13234 J	3.39 J	4250	185
8 KSU 0-12	10.3	8.95	16.7	13318 J	102	1720	669 J
8 KSU 24-36	13.6	6.73	13.3	14872 J	12	2377	408 J
8 KSU 48-60	13.6	10.8	15.2	18646 J	13.1	2469	762 J
9 KSU 0-12	16.5	9.07	14.5	17319 J	12.1	2164	536 J
9 KSU 24-36	12.4	21.5	12.1	15058 J	26.9	1478	1602 J
9 KSU 48-60	17.5	17.4	15.2	18569 J	17.3	2001	1187 J
10 KSU 0-12	14.6	11.1	16.5	19620 J	51	2751	916 J
10 KSU 24-36	14.3	11	15.8	19382 J	20.9	2566	717 J
10 KSU 48-60	16.7	13	19.8	22088 J	25.1	3078	612 J
17 KSU 0-12	8.9	8.7	14.1	13401 J	11	1978	536
17 KSU 24-36	10.8	8.9	15.2	14878 J	12.2	2731	862
17 KSU 48-60	12.1	10.3	13.8	15262 J	11.9	2981	772
25 KSU 0-12	18.4	14.7	13.1	14986	14.2	2323	796 J
25 KSU 24-36	17.5	6.62	13.3	24718	11.97	2375	719 J
25 KSU 48-60	23.3	10.1	13.9	23566	10.23 J	4392	1132 J
26 KSU 0-12	12.5	12.2	12.8	15021	16.4	1924	896 J
26 KSU 24-36	16.6	14.1	18.7	22700	30	3290	1074 J
26 KSU 48-60	15.5	9.88	19.1	20476	15.6	3360	697 J
2 SMO 0-12	22.2	9.96	15.9	17200 J	24.7	3376	617
2 SMO 24-36	24.9	14.7 J	30.8	33070 J	14.2 J	5197	1347
2 SMO 48-60	16.7	14.1	17.9	25948 J	12.3 J	5278	958
3 SMO 0-12	13.7	9.59	20.4	18968 J	65.5	2103	744
3 SMO 24-36	10.7	8.94	12.4	13395 J	12.4	2067	685
3 SMO 48-60	9.25	10.2	16.5	15305 J	15.7	2425	974
7 SMO 0-12	11.8	11.6	14.8	14013 J	18.5	1831	1002 J
7 SMO 24-36	19.8	13.5	22.1	26783 J	36.9	4514	908 J
7 SMO 48-60	14.5	17.3	19.3	20405 J	19.8	3680	1499 J
11 SMO 0-12	25.2	18.5	22.4	25208 J	33.8	2956	636 J
11 SMO 24-36	23.1	15 J	21.2	48073 J	15.3 J	5004	3276
11 SMO 48-60	29.9	25.7	29.5	36887 J	30.1	5061	1583 J
12 SMO 0-12	20.5	14.4	18.9	27572	25.1	3064	1191 J
12 SMO 24-36	20.3	10.2	16.3	26612	26.7	2778	954 J
12 SMO 48-60	17.7	11.6	18.5	31433	35.1	3311	1244 J
14 SMO 0-12	11.3	10	12.2	13956 J	13.7	1843	865 J
14 SMO 24-36	9.58	7.85	9.32	13002 J	12.7	1403	593 J
14 SMO 48-60	19.7	10.8	12.6	15280 J	15.3	1462	525 J
20 SMO 0-12	7.91	4.82	8.35	9355 J	8.8	1996	304
20 SMO 24-36	11.9	14.5	17	14869 J	20.3	3166	336
20 SMO 48-60	16.6	10.6	13.2	12488 J	3.54	4135	173
27 SMO 0-12	11.5	4.54 J	17.2	9136 J	288	3034	364
27 SMO 24-36	13.2	9.95	13.4	17420 J	20.3	1398	676
27 SMO 48-60	13.5	10.9	12.7	18335 J	17.4	1639	790

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Table 3
Metals Results (mg/kg)
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Sample ID	Mercury	Nickel	Potassium	Selenium	Sodium	Thallium	Vanadium	Zinc
15 KCB 0-12	0.0255 U	16.9	1197	0.0975 U	43.9 J	0.85 U	24.5	56.9
15 KCB 24-36	0.025 U	19.6	1204	0.0925 U	52.2 J	0.81 U	25	51.7
15 KCB 48-60	0.024 U	0.352 U	58.5 U	0.095 U	38.8 J	0.82 U	0.164 U	0.117 U
19 KCB 0-12	0.084 J	18.6	1804	0.101 U	32.3 J	0.875 U	20.7	87.4
19 KCB 24-36	0.026 U	15.1	939	0.097 U	32.8 J	0.855 U	19.6	41.6
19 KCB 48-60	0.026 U	16.7	1233	0.098 U	34.7 J	0.855 U	16.7	41.2
21 KCB 0-12	0.05 J	15.2	946	0.094 UJ	397 J	0.83 U	20.2	40.8
21 KCB 24-36	0.074 J	20.3	1036	0.101 UJ	449 J	0.89 U	28.8	59.4
21 KCB 48-60	0.054 J	17.4	1170	0.0965 J	525	0.87 U	17.2	49.9
22 KCB 0-12	0.028 U	19.3	2103	0.242 J	59.3 J	3.84 J	29.8	60.5
22 KCB 24-36	0.065 J	29.6	2311	0.174 J	83.7 J	0.845 U	35.6	78.6
22 KCB 48-60	0.0265 U	28.9	1940	0.091 J	101 J	0.845 U	28.6	68.1
24 KCB 0-12	0.075	14.3	1100	0.0995 UJ	415 J	0.885 U	14.3	37.2
24 KCB 24-36	0.0245 U	15	1370	0.0945 U	383 J	0.825 U	21.6	39.7
24 KCB 48-60	0.025 U	19.3	1434	0.097 U	447 J	0.85 U	20.1	45.2
28 KCB 0-12	0.067 J	64	1413	0.101 U	75 J	8.88 J	44.3	415
28 KCB 24-36	0.0255 U	21.3	1223	0.096 U	37.6 J	5.43 J	21.6	58.2
28 KCB 48-60	0.0235 U	24	1667	0.0995 U	66.3 J	8.52 J	36.5	63.8
29 KCB 0-12	0.056 J	19.1	1686	0.0975 U	26 J	3.05 J	18.5	53.5
29 KCB 24-36	0.051 J	15.1	1145	0.0915 U	22.2 J	4.94 J	11.1	44.9
29 KCB 48-60	0.025 U	14.9	1141	0.0945 U	16.6 J	1.79 J	11.3	33.8
30 KCB 0-12	0.026 U	18	1478	0.0965 U	401 J	0.845 U	15.8	46.9
30 KCB 24-36	0.0245 U	17.6	1579	0.094 U	358 J	0.82 U	20.9	46.9
30 KCB 48-60	0.0245 U	17.6	1225	0.096 U	330 J	0.845 U	16.4	38.2
1 KSU 0-12	0.08	14.5	518	0.0925 U	81.2 J	4.86 J	14.2	182
1 KSU 24-36	0.024 U	13.6	1253	0.0905 U	86.4 J	0.8 U	15.6	32.3
1 KSU 48-60	0.022 U	13	1203	0.0895 U	66.9 J	0.81 U	12.7	29.7
4 KSU 0-12	0.025 U	42.1	951	0.101 U	754 J	6.35 J	24.4	57.2
4 KSU 24-36	0.024 U	56.2	1850	0.098 U	717 J	1.71 U	17.1	78.7
4 KSU 48-60	0.0245 U	41.4	737	2.705 UJ	412 J	2.935 J	11.4	50.3
8 KSU 0-12	0.124	16.5	1460	0.248 J	28.7 J	2.82 J	21.7	127
8 KSU 24-36	0.077	18.5	1341	0.0935 U	84.2 J	3.33 J	21.5	38.9
8 KSU 48-60	0.081	22	765	0.095 U	99.1 J	4.55 J	25.1	44.4
9 KSU 0-12	0.026 U	20.9	1262	0.1 U	55.1 J	4.12 J	28.1	41.1
9 KSU 24-36	0.0265 U	22.4	641	0.101 U	45.1 J	6.11 J	28.5	35.3
9 KSU 48-60	0.0255 U	26	895	0.1 U	149 J	7.47 J	31.7	33.6
10 KSU 0-12	0.075 J	21.9	1259	0.248	42.4 J	3.05 J	29.8	72.7
10 KSU 24-36	0.077 J	21.1	748	0.202	43.2 J	3.72 J	27.7	66.1
10 KSU 48-60	0.11	22.7	1219	0.237	46.5 J	0.84 U	32.6	79.7
17 KSU 0-12	0.0245 U	15.1	1354	0.096 U	353 J	0.84 U	18	40.5
17 KSU 24-36	0.0235 U	18.9	635	0.096 U	484	4.39 J	21.4	48.3
17 KSU 48-60	0.025 U	20.3	1076	0.097 U	121 J	3.29 J	24.1	47.5
25 KSU 0-12	0.025 U	29.5	733	0.009 U	80 J	3 J	26.5	45.4
25 KSU 24-36	0.026 U	28.1	947	0.0095 U	114 J	2.2 J	36.4	42.7
25 KSU 48-60	0.025 U	53.3	1636	0.0095 U	221 J	2.5 J	24.1	56.6
26 KSU 0-12	0.058 J	20.5	875	0.124	157 J	0.87 U	26.3	80.1
26 KSU 24-36	0.074 J	32	1097	0.158	336 J	2.36 J	32.8	64.6
26 KSU 48-60	0.073 J	29.8	1178	0.091	305 J	0.89 U	28.6	62.4
2 SMO 0-12	0.045 U	28.7	1117	0.1005 U	497	2.2 J	23.1	51.1
2 SMO 24-36	0.026 U	55.9	1568	0.1045 U	2422	3.25 U	21.9 J	117
2 SMO 48-60	0.026 U	55.9	2339	0.0985 U	2195	5 J	16.2	98.8
3 SMO 0-12	0.097 J	20	1691	0.1035 U	41.4 J	0.90 U	24	107
3 SMO 24-36	0.051 J	18.2	1063	0.095 U	54.2 J	0.83 U	19	40.7
3 SMO 48-60	0.067 J	12.8	546	0.098 U	77.6 J	3.74 J	22	44.1
7 SMO 0-12	0.077 J	36.3	699	0.276	28.6 J	0.91 U	20.3	84.3
7 SMO 24-36	0.074 J	27.6	315 U	0.174	141 J	0.88 U	36.9	80.9
7 SMO 48-60	0.068 J	28.2	1108 J	0.21	195 J	4.52 J	28	65.1
11 SMO 0-12	0.076 J	33.6	619	0.316	62.8 J	3.67 J	39.9	96.5
11 SMO 24-36	0.026 U	83	1311	0.158	166 J	4.34 U	22.6 J	78
11 SMO 48-60	0.094 J	100	1266	0.418	123 J	4.21 J	30.8	101
12 SMO 0-12	0.091 J	35.8	910 J	0.0095 U	121 J	1.64 U	39.7	65.9
12 SMO 24-36	0.073 J	38.5	530 J	0.0095 U	224 J	4.34 J	27.9	54.7
12 SMO 48-60	0.052 J	53.1	1251	0.156	418 J	1.80 U	16.2	70.2
14 SMO 0-12	0.072 J	16.9	988	0.0895 U	85 J	1.92 J	24.5	35.2
14 SMO 24-36	0.086 J	12.8	1189	0.0915 U	56.4 J	3.77 J	24.7	28.8
14 SMO 48-60	0.081 J	14.7	582	0.0935 U	71.9 J	4.96 J	31	30.1
20 SMO 0-12	0.02 U	12.1	1145	0.0855 U	64.3 J	0.74 U	15.1	31.8
20 SMO 24-36	0.109	45.6	1541	0.0955 U	46.2 J	1.755 UJ	11.5	47
20 SMO 48-60	0.021 U	42.1	918 J	0.0915 U	405 J	0.81 U	9.8	49.9
27 SMO 0-12	0.076 J	14.4	669	7.55 U	80.9 J	4.40 U	12.3 J	1155
27 SMO 24-36	0.084 J	16.3	979	0.1015 U	30.6 J	0.89 U	29.7	55.8
27 SMO 48-60	0.062 J	16.8	964	0.1015 U	29.7 J	4.77 J	30.2	43.8

Notes: 'J' means concentration is estimated. 'U' means the analyte was not detected.
Underlined qualifiers were assigned during QC review.
Italics show concentrations at half the detection limit for 'U' qualified data.
Hexavalent chromium and silver were analyzed, but not detected in any samples.

Table 4
PAHs Results (ng/kg)
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene
15 KCB 0-12	496 J	*258.5* U	986 J	10362	11353	13657	10052	10818
19 KCB 0-12	*239.5* U	*264* U	2888 J	25957	28861	29708	21943	25137
21 KCB 0-12	228	*252* U	*462* U	*758* U	*660* U	1345 J	*581.5* U	*732.5* U
22 KCB 0-12	*249* U	*274.5* U	*504* U	2334 JJ	1675 J	3416 JJ	2036 JJ	2832 JJ
24 KCB 0-12	*239.5* U	*264.5* U	*485.5* U	4879 J	4709 J	6817 J	5813 J	4734 J
28 KCB 0-12	*239* U	*263.5* U	1650 J	2118 J	2003 J	2660 J	2535 J	2526 J
29 KCB 0-12	*233.5* U	*257.5* U	*472.5* U	2581	2787 J	3954 J	3303 J	3194 J
30 KCB 0-12	*228.5* U	*252* U	2588 J	15687	17664	20669	16259	14310
1 KSU 0-12	174299	*10985.5* U	165289 J	29904	464348	460676	449134	223870
4 KSU 0-12	*243.5* U	*269* U	*493.5* U	2023 J	5810 J	4394 J	24279	5469 J
8 KSU 0-12	*242* U	*267* U	*490.5* U	*818* U	6493 J	5935 JJ	33448 J	6353 JJ
9 KSU 0-12	1810	*261.5* U	6619 J	19682	23779	21794	83736	14632
10 KSU 0-12	*234* U	*258* U	3834 J	15862	14298	23202	16713	14298
17 KSU 0-12	*227.5* U	*251* U	*461* U	1563 J	*658.5* U	1933 J	1238 J	*742* U
25 KSU 0-12	*242.5* U	*247* U	5372 J	37264	37680	43294	27048	27966
26 KSU 0-12	8469	*258* U	17611	*790* U	48527	52478	38425	37504
2 SMO 0-12	*242* U	*267.5* U	*490.5* U	3928 J	2912 J	4106 J	2858 J	3300
3 SMO 0-12	*250* U	*275.5* U	*506* U	2979 J	2623 J	4109 J	3071 J	3499
7 SMO 0-12	*249* U	*275* U	6779 J	*840* U	49374	61214	41419	35314
11 SMO 0-12	*237* U	*261.5* U	*480.5* U	10717	8166	12282	10542	6783 J
12 SMO 0-12	*222.5* U	*245* U	*450.5* U	*750* U	*643.5* U	*643.5* U	*575.5* U	*725* U
14 SMO 0-12	*213.5* U	*235* U	*432.5* U	*720* U	*617.5* U	*617.5* U	*552.5* U	*696* U
20 SMO 0-12	*206.5* U	1001 J	2744 J	11232	11754	13472	17166	10250
27 SMO 0-12	*241.5* U	*266.5* U	10024	54267	48017	44738 J	46844 J	43561 J

Notes: 'J' means concentration is estimated. 'U' means the analyte was not detected.
Underlined qualifiers were assigned during QC review.
Italics show concentrations at half the detection limit for U qualified data.

Table 4
PAHs Results (ng/kg)
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
15 KCB 0-12	14068	2864 J	23739	*353.5* U	10825	1768 J	9702	19583
19 KCB 0-12	32164	6109 J	49335	741	24555	2112 J	15893	44302
21 KCB 0-12	*539* U	*347* U	*628.5* U	*344.5* U	*903.5* U	*399* U	*485.5* U	*385* U
22 KCB 0-12	2409 JJ	*384* U	1897 JJ	*376* U	*1000* U	*435.5* U	1146 JJ	2924 JJ
24 KCB 0-12	6498 J	*370* U	11610	*362* U	5086 J	*419.5* U	5459 J	8862
28 KCB 0-12	2577 J	*371* U	2746 J	*361* U	2701 J	*418.5* U	1499 J	2565 J
29 KCB 0-12	3698 J	2301 J	4997 J	*352.5* U	3421 J	*408.5* U	2370 J	4328 J
30 KCB 0-12	19476	4695 J	33227	*345* U	16792	1116 J	10931	26904
1 KSU 0-12	686842	214031	1335751 J	150161	423303	78697 J	922137	1155417 J
4 KSU 0-12	2201 J	20919	1916 J	*368* U	23826	*426.5* U	*518.5* U	1989 J
8 KSU 0-12	2157 JJ	34008	*677.5* U	1231	37938	2935 J	1244 J	1521 JJ
9 KSU 0-12	25947	9377	48184	1556	23016	1894 J	23480	37079
10 KSU 0-12	19092	8037 J	41092	*353.5* U	14802	*409.5* U	20703	28257
17 KSU 0-12	1702 J	*351.5*	1995 J	*343.5* U	*915* U	*398* U	*484.5* U	1092 J
25 KSU 0-12	45897	7939	92018	*338* U	30688	*392* U	15499	67367
26 KSU 0-12	58287	15858	122318	5475	38993	4475 J	79355	96472
2 SMO 0-12	4348 J	*373.5* U	6330 J	*365.5* U	2631 J	*423.5* U	2465 J	4409 J
3 SMO 0-12	3988 J	*386* U	6261 J	*377.5* U	3159 J	*437.5* U	2807 J	4914 J
7 SMO 0-12	53771	11089	101996	1737	42333	3501 J	42303	79562
11 SMO 0-12	15507	3579 J	16430	*358.5* U	7841 J	2257 J	4974 J	21668
12 SMO 0-12	*525.5* U	*343* U	*621.5* U	*336* U	*894* U	*389* U	1832 J	*375.5* U
14 SMO 0-12	*504* U	*329.5* U	*597* U	*322* U	*858.5* U	*373* U	*454* U	*360* U
20 SMO 0-12	14206	8470	29022 J	1031	14396	1953 J	15238	21426 J
27 SMO 0-12	87710 J	13655	90992 J	*364.5* U	35784	25189 J	144228	118029 J

Notes: 'J' means concentration is estimated. 'U' means the analyte was not detected.
Underlined qualifiers were assigned during QC review.
Italics show concentrations at half the detection limit for U qualified data.

Table 5
Lab Measured pH Results
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Soil Association	Depth bgs (inches)	pH	Hydrogen Ions
15	KCB	0-12	6.71	1.95E-07
19	KCB	0-12	6.79	1.62E-07
21	KCB	0-12	6.68	2.09E-07
22	KCB	0-12	6.87	1.35E-07
24	KCB	0-12	6.69	2.04E-07
28	KCB	0-12	7.6	2.51E-08
29	KCB	0-12	6.89	1.29E-07
30	KCB	0-12	6.97	1.07E-07
Average in KCB Soils 0-12 in. bgs				**6.84**
15	KCB	24-36	6.06	8.71E-07
19	KCB	24-36	6.9	1.26E-07
21	KCB	24-36	6.97	1.07E-07
22	KCB	24-36	5.31	4.90E-06
24	KCB	24-36	6.51	3.09E-07
28	KCB	24-36	7.3	5.01E-08
29	KCB	24-36	6.6	2.51E-07
30	KCB	24-36	6.36	4.37E-07
Average in KCB Soils 12-24 in. bgs				**6.05**
15	KCB	48-60	5.96	1.10E-06
19	KCB	48-60	6.64	2.29E-07
21	KCB	48-60	7.23	5.89E-08
24	KCB	48-60	6.54	2.88E-07
28	KCB	48-60	7.38	4.17E-08
29	KCB	48-60	6.34	4.57E-07
30	KCB	48-60	6.32	4.79E-07
Average in KCB Soils 48-60 in. bgs				**6.42**

Notes:
Soil pH was analyzed using EPA Method SW846-9045C.
Replicate samples were averaged.

Table 5
Lab Measured pH Results
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Soil Association	Depth bgs (inches)	pH	Hydrogen Ions
1	KSU	0-12	7	1.00E-07
4	KSU	0-12	6.7	2.00E-07
8	KSU	0-12	7.48	3.31E-08
9	KSU	0-12	7.41	3.89E-08
10	KSU	0-12	6.44	3.63E-07
17	KSU	0-12	7.66	2.19E-08
25	KSU	0-12	5.72	1.91E-06
26	KSU	0-12	7.22	6.03E-08
Average in KSU Soils 0-12 in. bgs				**6.47**
1	KSU	24-36	7.61	2.45E-08
4	KSU	24-36	8.28	5.25E-09
8	KSU	24-36	7.4	3.98E-08
9	KSU	24-36	7.43	3.72E-08
10	KSU	24-36	7.47	3.39E-08
17	KSU	24-36	5.28	5.25E-06
25	KSU	24-36	6.17	6.76E-07
26	KSU	24-36	7.05	8.91E-08
Average in KSU Soils 24-36 in. bgs				**6.11**
1	KSU	48-60	7.71	1.95E-08
4	KSU	48-60	8.44	3.63E-09
8	KSU	48-60	6.72	1.91E-07
9	KSU	48-60	7.6	2.51E-08
10	KSU	48-60	7.04	9.12E-08
17	KSU	48-60	6.29	5.13E-07
25	KSU	48-60	6.07	8.51E-07
26	KSU	48-60	6.72	1.91E-07
Average in KSU Soils 48-60 in. bgs				**6.63**

Notes:
Soil pH was analyzed using EPA Method SW846-9045C.
Replicate samples were averaged.

Table 5
Lab Measured pH Results
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Soil Association	Depth bgs (inches)	pH	Hydrogen Ions
2	SMO	0-12	7.76	1.74E-08
3	SMO	0-12	6.73	1.86E-07
7	SMO	0-12	6.44	3.63E-07
11	SMO	0-12	6.29	5.13E-07
12	SMO	0-12	6.29	5.13E-07
14	SMO	0-12	6.41	3.89E-07
20	SMO	0-12	6.77	1.70E-07
27	SMO	0-12	7.4	3.98E-08
Average in SMO Soils 0-12 in. bgs				**6.56**
2	SMO	24-36	7.54	2.88E-08
3	SMO	24-36	7.63	2.34E-08
7	SMO	24-36	5.28	5.25E-06
11	SMO	24-36	7.45	3.55E-08
12	SMO	24-36	6.04	9.12E-07
14	SMO	24-36	5.83	1.48E-06
20	SMO	24-36	8.01	9.77E-09
27	SMO	24-36	7.48	3.31E-08
Average in SMO Soils 24-36 in. bgs				**6.01**
2	SMO	48-60	7.71	1.95E-08
3	SMO	48-60	7.13	7.41E-08
7	SMO	48-60	5.94	1.15E-06
11	SMO	48-60	7.05	8.91E-08
12	SMO	48-60	7.24	5.75E-08
14	SMO	48-60	5.97	1.07E-06
20	SMO	48-60	8.26	5.50E-09
27	SMO	48-60	7.43	3.72E-08
Average in SMO Soils 48-60 in. bgs				**6.50**

Notes:
Soil pH was analyzed using EPA Method SW846-9045C.
Replicate samples were averaged.

Table 6
Cation Exchange Capacity Results
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Soil Association	Depth bgs (inches)	Percent Moisture	Cation Exchange Capacity (wet wt basis) mequiv/100
15	KCB	0-12	17.5%	18.3
15	KCB	24-36	13.8%	20.3
15	KCB	48-60	15.4%	16.2
24	KCB	0-12	21.7%	9.65
24	KCB	24-36	15.1%	16.9
24	KCB	48-60	16.6%	15
			KCB Average	16.1
4	KSU	0-12	19.6%	22.3
4	KSU	24-36	14.4%	18.1
4	KSU	48-60	14.3%	9.13
10	KSU	0-12	17.1%	13.9
10	KSU	24-36	16.8%	15.5
10	KSU	48-60	15.9%	16
17	KSU	0-12	16.7%	14
17	KSU	24-36	16.9%	11.9
17	KSU	48-60	17.1%	9.74
			KSU Average	14.5
2	SMO	0-12	21.0%	17.3
2	SMO	24-36	31.3%	23.7
2	SMO	48-60	19.3%	16.6
3	SMO	0-12	18.9%	17.3
3	SMO	24-36	16.8%	17.7
3	SMO	48-60	13.9%	19.7
11	SMO	0-12	15.8%	18.6
11	SMO	24-36	23.1%	19.6
11	SMO	48-60	20.0%	19.7
			SMO Average	18.9

Notes:
Cation Exchange Capacity (CEC) was analyzed using EPA Method 9081C.
Replicate samples were averaged.

Table 7
Total Organic Carbon Results
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Soil Association	Depth bgs (inches)	Total Organic Carbon (mg/kg)	Total Organic Carbon (as percent)
15	KCB	0-12	1789	0.18%
19	KCB	0-12	7368	0.74%
21	KCB	0-12	3787	0.38%
22	KCB	0-12	1920	0.19%
24	KCB	0-12	3123	0.31%
28	KCB	0-12	3208	0.32%
29	KCB	0-12	5803	0.58%
30	KCB	0-12	7020	0.70%
				0.43%
1	KSU	0-12	3292	0.33%
4	KSU	0-12	1722	0.17%
8	KSU	0-12	8574	0.86%
9	KSU	0-12	3936	0.39%
10	KSU	0-12	1407	0.14%
17	KSU	0-12	3558	0.36%
25	KSU	0-12	1473	0.15%
26	KSU	0-12	1739	0.17%
				0.32%
2	SMO	0-12	6310	0.63%
3	SMO	0-12	1147	0.11%
7	SMO	0-12	8716	0.87%
11	SMO	0-12	4595	0.46%
12	SMO	0-12	1257	0.13%
14	SMO	0-12	4909	0.49%
20	SMO	0-12	4993	0.50%
27	SMO	0-12	11599	1.16%
				0.54%
Average in Soils 0-12 in. bgs				**0.43%**

Notes:
Total Organic Carbon (TOC) was analyzed using ASTM Method D2974.
Replicate samples were averaged.

Table 7
Total Organic Carbon Results
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Soil Association	Depth bgs (inches)	Total Organic Carbon (mg/kg)	Total Organic Carbon (as percent)
15	KCB	24-36	4362	0.44%
19	KCB	24-36	9233	0.92%
21	KCB	24-36	3943	0.39%
22	KCB	24-36	4085	0.41%
24	KCB	24-36	8075	0.81%
28	KCB	24-36	5504	0.55%
29	KCB	24-36	2716	0.27%
30	KCB	24-36	5713	0.57%
				0.55%
1	KSU	24-36	7039	0.70%
4	KSU	24-36	3588	0.36%
8	KSU	24-36	6444	0.64%
9	KSU	24-36	3690	0.37%
10	KSU	24-36	2859	0.29%
17	KSU	24-36	7892	0.79%
25	KSU	24-36	1382	0.14%
26	KSU	24-36	3461	0.35%
				0.45%
2	SMO	24-36	7528	0.75%
3	SMO	24-36	4830	0.48%
11	SMO	24-36	230	0.02%
12	SMO	24-36	573	0.06%
14	SMO	24-36	4328	0.43%
20	SMO	24-36	6808	0.68%
27	SMO	24-36	6742	0.67%
				0.44%
Average in Soils 24-36 in. bgs				**0.49%**

Notes:
Total Organic Carbon (TOC) was analyzed using ASTM Method D2974.
Replicate samples were averaged.

Table 7
Total Organic Carbon Results
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Soil Association	Depth bgs (inches)	Total Organic Carbon (mg/kg)	Total Organic Carbon (as percent)
15	KCB	48-60	5434	0.54%
19	KCB	48-60	970	0.10%
21	KCB	48-60	4919	0.49%
22	KCB	48-60	3604	0.36%
24	KCB	48-60	6017	0.60%
28	KCB	48-60	6777	0.68%
29	KCB	48-60	5658	0.57%
30	KCB	48-60	5821	0.58%
				0.49%
4	KSU	48-60	2171	0.22%
8	KSU	48-60	2670	0.27%
9	KSU	48-60	3961	0.40%
10	KSU	48-60	3101	0.31%
17	KSU	48-60	10223	1.02%
25	KSU	48-60	1859	0.19%
26	KSU	48-60	1685	0.17%
				0.37%
2	SMO	48-60	7468	0.75%
3	SMO	48-60	4271	0.43%
7	SMO	48-60	523	0.05%
11	SMO	48-60	3309	0.33%
12	SMO	48-60	808	0.08%
14	SMO	48-60	9131	0.91%
20	SMO	48-60	7923	0.79%
27	SMO	48-60	12317	1.23%
				0.57%
Average in Soils 48-60 in. bgs				**0.48%**

Notes:
Total Organic Carbon (TOC) was analyzed using ASTM Method D2974.
Replicate samples were averaged.

Table 8
Dry Bulk Density/ Moisture Content Results
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Sample ID	Soil Association	Depth bgs (inches)	Moisture Content (percent)	Dry Unit Weight (pcf)	Dry Unit Weight (g/cm^3)
15	KCB	0-36	24.2	97.0	1.554
19	KCB	0-36	22.8	98.9	1.584
22	KCB	0-36	22.6	103.7	1.660
24	KCB	0-36	18.9	102.4	1.640
30	KCB	0-36	21.5	106.4	1.704
Average in KCB Soils 0-36 in. bgs					**1.629**
15	KCB	36-60	18.3	102.2	1.637
19	KCB	36-60	22.5	104.8	1.679
22	KCB	36-60	18.5	107.8	1.727
24	KCB	36-60	20.4	101.0	1.618
30	KCB	36-60	18.1	113.5	1.818
Average in KCB Soils 36-60 in. bgs					**1.696**
4	KSU	0-36	30.3	97.6	1.563
8	KSU	0-36	26.7	96.9	1.552
10	KSU	0-36	23.8	101.9	1.632
17	KSU	0-36	19.1	98.9	1.584
Average in KSU Soils 0-36 in. bgs					**1.583**
4	KSU	36-60	17.0	113.8	1.823
8	KSU	36-60	20.6	104.8	1.679
10	KSU	36-60	18.1	107.5	1.722
17	KSU	36-60	20.3	98.2	1.573
Average in KSU Soils 36-60 in. bgs					**1.699**
2	SMO	0-36	28.2	96.9	1.552
3	SMO	0-36	18.7	107.4	1.720
11	SMO	0-36	29.2	95.0	1.522
14	SMO	0-36	16.6	107.0	1.714
Average in SMO Soils 0-36 in. bgs					**1.627**
2	SMO	36-60	22.0	110.7	1.773
3	SMO	36-60	15.7	91.3	1.462
11	SMO	36-60	21.3	104.7	1.677
14	SMO	36-60	17.0	111.2	1.781
Average in SMO Soils 36-60 in. bgs					**1.674**

Notes:
Soil Bulk Density was analyzed using ASTM Method D2937.
Replicate samples were averaged.

Table 10
Distributions Compared for Association Sampling Intervals (n=8) and Soil Associations (n=24)
Blue Valley Soils Background Study
Brownfields Showcase Project

Metal	KCB*	0-12" KCB	24-36" KCB	48-60" KCB	KSU*	0-12" KSU	24-36" KSU	48-60" KSU	SMO*	SMO 0-12"	SMO 24-36"	SMO 48-60"
Aluminum	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L
Antimony	Nonparametric	Nonparametric	Nonparametric	-	Nonparametric	-	-	Nonparametric	Nonparametric	Nonparametric	-	-
Arsenic	Lognormal	Lognormal	Normal	N/L	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L
Barium	Normal	N/L	N/L	Normal	Normal	N/L	N/L	N/L	Lognormal	Lognormal	N/L	N/L
Beryllium	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L
Cadmium	Normal	Lognormal	N/L	Normal	Normal	N/L	N/L	Normal	Lognormal	N/L	N/L	N/L
Calcium	Normal	Normal	N/L	N/L	Normal	N/L	Lognormal	N/L	Lognormal	N/L	Lognormal	Lognormal
Chromium	Normal	Lognormal	N/L	Normal	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L
Chromium VI	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	Lognormal	Lognormal	N/L	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L	Lognormal
Copper	Normal	N/L	N/L	Normal	Normal	N/L	N/L	N/L	Normal	N/L	N/L	N/L
Iron	Normal	N/L	N/L	Normal	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L
Lead	Normal	Lognormal	N/L	Normal	Lognormal	N/L	N/L	N/L	Lognormal	N/L	N/L	N/L
Magnesium	Lognormal	Lognormal	N/L	Normal	Lognormal	Lognormal	Lognormal	N/L	N/L	N/L	N/L	N/L
Manganese	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L
Mercury	Lognormal	N/L	Nonparametric	Nonparametric	Nonparametric	N/L	Nonparametric	Nonparametric	Normal	Normal	N/L	N/L
Nickel	Nonparametric	N/L	N/L	Normal	Lognormal	N/L	N/L	N/L	Lognormal	N/L	N/L	N/L
Potassium	Normal	N/L	N/L	Normal	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L
Selenium	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric
Silver	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal
Thallium	Nonparametric	Nonparametric	Nonparametric	Nonparametric	N/L	N/L	N/L	N/L	Nonparametric	Nonparametric	Nonparametric	N/L
Vanadium	Normal	N/L	N/L	Normal	Normal	N/L	N/L	Normal	Normal	N/L	N/L	Normal
Zinc	Normal	N/L	N/L	Normal	Lognormal	N/L	N/L	N/L	N/L	N/L	N/L	N/L

Notes:
N/L means dataset tests both normal and lognormal; dataset statistically evaluated as a normal distribution.
Population size is initial sampling population and is not adjusted for outliers removed.
Asterisks indicate populations that are n=24. Other populations shown in table are n=8.
Dashes indicate populations in which a metal was nondetect.

KCB = Kennebec Colo Bremer Soil Association
KSU = Knox Sibley Urban Soil Association
SMO = Snead Menfro Oska Soil Association

Table 11
Distributions Compared for Association Sampling Intervals (n=8) and Sampling Intervals (n=24)
Blue Valley Soils Background Study
Brownfields Showcase Project

Metal	0-12 in *	0-12" KCB	0-12" KSU	SMO 0-12"	24-36 in *	24-36" KCB	24-36" KSU	SMO 24-36"	48-60 in *	48-60" KCB	48-60" KSU	SMO 48-60"
Aluminum	Normal	N/L	N/L	N/L	Normal	N/L	N/L	N/L	Normal	N/L	N/L	N/L
Antimony	Nonparametric	Nonparametric	-	Nonparametric	Nonparametric	Nonparametric	-	-	Nonparametric	-	Nonparametric	-
Arsenic	N/L	Lognormal	N/L	N/L	Normal	Normal	N/L	N/L	N/L	N/L	N/L	N/L
Barium	N/L	N/L	N/L	Lognormal	N/L	N/L	N/L	N/L	Normal	Normal	N/L	N/L
Beryllium	N/L	N/L	N/L	N/L	N/L	N/L	N/L	N/L	Normal	N/L	N/L	N/L
Cadmium	N/L	Lognormal	N/L	N/L	N/L	N/L	N/L	N/L	Normal	Normal	Normal	N/L
Calcium	Lognormal	Normal	N/L	N/L	Lognormal	N/L	Lognormal	Lognormal	Normal	N/L	N/L	Lognormal
Chromium	Lognormal	Lognormal	N/L	N/L	Normal	N/L	N/L	N/L	Normal	Normal	N/L	N/L
Chromium VI	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	Normal	Lognormal	N/L	N/L	Normal	N/L	N/L	N/L	Normal	Normal	N/L	Lognormal
Copper	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L	Normal	Normal	N/L	N/L
Iron	Normal	N/L	N/L	N/L	N/L	N/L	N/L	N/L	Normal	Normal	N/L	N/L
Lead	Lognormal	Lognormal	N/L	N/L	N/L	N/L	N/L	N/L	Normal	Normal	N/L	N/L
Magnesium	N/L	Lognormal	Lognormal	N/L	Lognormal	N/L	Lognormal	N/L	Normal	Normal	N/L	N/L
Manganese	N/L	N/L	N/L	N/L	Normal	N/L	N/L	N/L	Normal	N/L	N/L	N/L
Mercury	N/L	N/L	N/L	Normal	N/L	Nonparametric	Nonparametric	N/L	Nonparametric	Nonparametric	Nonparametric	N/L
Nickel	Lognormal	N/L	N/L	N/L	Lognormal	N/L	N/L	N/L	Lognormal	Normal	N/L	N/L
Potassium	Normal	N/L	N/L	N/L	Normal	N/L	N/L	N/L	Normal	Normal	N/L	N/L
Selenium	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric
Silver	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal
Thallium	Lognormal	Nonparametric	N/L	Nonparametric	Nonparametric	Nonparametric	N/L	Nonparametric	N/L	Nonparametric	N/L	N/L
Vanadium	Normal	N/L	N/L	N/L	Normal	N/L	N/L	N/L	Normal	Nonparametric	N/L	N/L
Zinc	Lognormal	N/L	N/L	N/L	N/L	N/L	N/L	N/L	Normal	Normal	Normal	Normal

Notes:
N/L means dataset tests both normal and lognormal; dataset statistically evaluated as a normal distribution.
Population size is based on original sampling population and is not adjusted for outliers removed.
Asterisks indicates populations that are n=24. Other populations shown in table are n=8.
Dashes indicate populations in which a metal was nondetect.

KCB = Kennebec Colo Bremer Soil Association
KSU = Knox Sibley Urban Soil Association
SMO = Snead Menfro Oska Soil Association

Table 12
Distributions Compared for All Data Combined, Soil Associations, and Sampling Intervals
Blue Valley Soils Background Study
Brownfields Showcase Project

Metal	All Samples Combined*	Soils Associations			Sampling Intervals		
		KCB	KSU	SMO	0-12 in	24-36 in	48-60 in
Aluminum	Lognormal	Normal	N/L	N/L	Normal	Normal	Normal
Antimony	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric
Arsenic	Normal	Lognormal	Normal	N/L	N/L	Normal	N/L
Barium	Normal	Normal	Normal	Lognormal	N/L	N/L	Normal
Beryllium	Normal	Normal	N/L	N/L	N/L	N/L	Normal
Cadmium	Normal	Normal	Normal	Lognormal	N/L	N/L	Normal
Calcium	Lognormal	Normal	Normal	Lognormal	Lognormal	Lognormal	Normal
Chromium	Lognormal	Normal	Normal	N/L	Lognormal	Normal	Normal
Chromium VI	-	-	-	-	-	-	-
Cobalt	N/L	Lognormal	N/L	N/L	Normal	Normal	Normal
Copper	Lognormal	Normal	Normal	Normal	Normal	N/L	Normal
Iron	Lognormal	Normal	Normal	N/L	Normal	N/L	Normal
Lead	Lognormal	Normal	Lognormal	Lognormal	Lognormal	N/L	Normal
Magnesium	Lognormal	Lognormal	Lognormal	N/L	N/L	Lognormal	Normal
Manganese	Normal	Normal	N/L	N/L	N/L	Normal	Normal
Mercury	Lognormal	Nonparametric	Nonparametric	Normal	N/L	N/L	Nonparametric
Nickel	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal
Potassium	Normal	Normal	Normal	N/L	Normal	Normal	Normal
Selenium	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric	Nonparametric
Silver	-	-	-	-	-	-	-
Sodium	Nonparametric	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal
Thallium	Nonparametric	Nonparametric	N/L	Nonparametric	Lognormal	Nonparametric	N/L
Vanadium	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Zinc	Lognormal	Normal	Lognormal	N/L	Lognormal	N/L	Normal

Notes:
N/L means dataset tests both normal and lognormal; dataset statistically evaluated as a normal distribution.
Population size is based on original sampling population and is not adjusted for outliers removed.
Asterisk indicates population is n=72. Other populations shown in table are n=24.
Dashes indicate populations in which a metal was nondetect.

KCB = Kennebec Colo Bremer Soil Association
KSU = Knox Sibley Urban Soil Association
SMO = Snead Menfro Oska Soil Association

Table 13
Background Determined by Association Sampling Intervals
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Metal	KCB 0-12in	KCB 24-36in	KCB 48-60in	KSU 0-12in	KSU 24-36in	KSU 48-60in	SMO 0-12in	SMO 24-36in	SMO 48-60in
Aluminum	16589	21288	20165	20855	25030	22884	24441	22429	19739
Antimony	2.92	2.63	-	-	-	1.93	2.92	-	-
Arsenic	17.7	15.3	10.4	16.4	18.7	13.5	24.2	16.3	22.8
Barium	192	251	373	382	419	482	628	433	650
Beryllium	1.11	0.93	1.50	1.49	1.26	1.69	1.64	1.82	1.73
Cadmium	2.02	1.14	0.940	1.77	0.986	0.977	1.59	1.56	1.50
Calcium	5286	5469	7213	8986	14814	7843	7470	17826	17092
Chromium	38.8	27.1	29.9	33.5	35.6	31.1	35.4	35.8	36.4
Chromium VI	-	-	-	-	-	-	-	-	-
Cobalt	15.6	20.5	22.7	18.6	27.3	21.4	25.2	21.1	23.1
Copper	24.3	27.3	31.4	19.4	24.3	28	22.5	39.4	35.2
Iron	28405	33296	36963	32481	35622	33633	38531	62941	49557
Lead	77.2	24.0	26	56.8	35.3	34.3	92.5	31.6	53.0
Magnesium	5818	4500	4918	6494	9373	6047	4565	8146	7996
Manganese	1074	1626	1274	1303	2109	1777	1680	1878	2491
Mercury	0.124	0.074	0.054	0.229	0.077	0.110	0.149	0.176	0.126
Nickel	24	34.8	43.7	52.0	43.2	69.8	56.6	113.5	134
Potassium	2699	2737	2988	2508	1924	2009	3307	1944	1964
Selenium	0.242	0.174	0.091	0.248	0.202	0.237	0.316	0.174	0.418
Silver	-	-	-	-	-	-	-	-	-
Sodium	269	272	335	322	401	540	290	395	636
Thallium	8.88	5.43	8.52	9.23	8.43	15.7	3.67	4.34	6.34
Vanadium	54.5	45.8	53.0	40.6	48.8	49.1	57.3	48.4	49.1
Zinc	111	93.2	109	240	105	102	168	152	146

Notes:
Units are mg/kg.
Initial population size was n=8.
Outliers were removed, as necessary, to achieve a parametric distribution.
Dashes indicate populations in which a metal was nondetect.

Table 14
Background Determined by Soil Associations
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Metal	KCB	KSU	SMO
Aluminum	16154	19403	19172
Antimony	2.92	1.93	3.93
Arsenic	13.9	13.5	17.5
Barium	240	360	599
Beryllium	1.14	1.27	1.49
Cadmium	0.93	0.831	3.94
Calcium	5288	5020	8113
Chromium	24.8	27.9	30.0
Chromium VI	-	-	-
Cobalt	16.9	17.0	19.5
Copper	27.3	21.7	29.9
Iron	27629	28935	38015
Lead	25.3	79.5	132
Magnesium	3865	5797	5985
Manganese	1244	1455	1703
Mercury	0.084	0.124	0.115
Nickel	27.1	60.2	114
Potassium	2262	1843	2083
Selenium	0.242	0.248	0.418
Silver	-	-	-
Sodium	176	426	1263
Thallium	8.88	7.45	5.00
Vanadium	43.0	39.7	43.4
Zinc	84.5	148	126

Notes:
Units are mg/kg.
Initial population size was n=24.
Outliers were removed, as necessary, to achieve a parametric distribution.
Dashes indicate populations in which a metal was nondetect.

Table 15
Background Determined by Sampling Intervals
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Metal	0-12 in	24-36 in	48-60 in
Aluminum	17624	19695	19102
Antimony	3.93	2.63	1.93
Arsenic	16.4	14.0	13.9
Barium	279	325	420
Beryllium	1.22	1.36	1.42
Cadmium	1.25	1.02	0.923
Calcium	14723	6580	6906
Chromium	31.9	28.0	28.7
Chromium VI	-	-	-
Cobalt	17.2	19.7	19.2
Copper	26.1	23.9	27.9
Iron	28323	32893	35510
Lead	87.6	26.8	33.8
Magnesium	3743	6825	5723
Manganese	1190	2267	1670
Mercury	0.123	0.117	0.110
Nickel	45.9	62.5	71.5
Potassium	2438	1710	2011
Selenium	0.316	0.202	0.418
Silver	-	-	-
Sodium	254	1900	1962
Thallium	8.24	6.11	9.63
Vanadium	43.2	40.6	42.6
Zinc	179	89.1	103

Notes:
Units are mg/kg.
Initial population size was n=24.
Outliers were removed, as necessary, to achieve a parametric distribution.
Dashes indicate populations in which a metal was nondetect.

Table 16
Background with All Samples Combined
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Metal	Background Value
Aluminum	19617
Antimony	3.93
Arsenic	10.7
Barium	316
Beryllium	1.25
Cadmium	1.15
Calcium	7582
Chromium	28.6
Chromium VI	-
Cobalt	18.2
Copper	25.8
Iron	29143
Lead	53.6
Magnesium	5161
Manganese	1372
Mercury	0.118
Nickel	66.8
Potassium	1955
Selenium	5.41
Silver	-
Sodium	2422
Thallium	8.88
Vanadium	39.4
Zinc	137

Notes:
Units are mg/kg.
Initial population size was n=72.
Outliers were removed, as necessary, to achieve a parametric distribution.
Dashes indicate populations in which a metal was nondetect.

Table 17
Background Levels for PAHs in Surface Soil
Blue Valley Soils Background Study

PAH	Frequency of Detection	Distribution	Minimum Detection	Maximum Detection	4X Median	95% UTL	Recommended Background Level
Acenaphthene	21%	Nonparametric	228	174,299			174,299
Acenaphthylene	4%	Nonparametric		1,001			1,001
Anthracene	46%	Nonparametric	986	165,289			165,289
Benzo(a)anthracene	71%	Lognormal	1,563	54,267	41,448	122,306	41,448
Benzo(a)pyrene	83%	Lognormal	1,675	464,348	29,126	386,434	386,434
Benzo(b)fluoranthene	92%	Lognormal	1,345	460,676	36,601	364,051	364,051
Benzo(g,h,i)perylene	88%	Lognormal	1,238	449,134	66,852	408,732	408,732
Benzo(k)fluoranthene	83%	Lognormal	2,526	223,870		223,574	223,574
Chrysene	88%	Lognormal	1,702	686,842	38,244	564,691	564,691
Dibenz(a,h)anthracene	63%	Lognormal	2,301	214,031	33,880	178,409	178,409
Fluoranthene	83%	Lognormal	1,897	1,335,751	104,992	1,270,926	1,270,926
Fluorene	29%	Nonparametric	741	150,161			150,161
Indeno(1,2,3-cd)pyrene	79%	Lognormal	2,631	423,303	67,168	323,322	323,322
Naphthalene	46%	Nonparametric	1,116	78,697			78,697
Phenanthrene	83%	Lognormal	1,146	922,137	20,843	596,343	596,343
Pyrene	88%	Lognormal	1,092	1,155,417	52,695	1,219,290	52,695

Notes:
Units are ng/kg (nanogram per kilogram).
Initial population size was n=24.

Table 18
Recommended Background Levels for Metals
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Metal	Frequency of Detection	Minimum Detection	Maximum Detection	Minimum Calculated Background Level	Maximum Calculated Background Level	Recommended Background Level
Aluminum	100%	4,175	20,059	16,154	25,030	25,030
Antimony	8%	1.93	3.93	-	-	3.93
Arsenic	100%	0.647	18	10.4	24	24
Barium	100%	5.18	457	192	650	650
Beryllium	99%	0.368	1.43	0.93	1.82	1.82
Cadmium	85%	0.274	11.6	0.831	3.94	3.94
Calcium	100%	924	172,030	5,020	17,826	17,826
Chromium	99%	6.66	29.9	24.8	38.8	38.8
Chromium VI	0%	-	-	-	-	-
Cobalt	99%	4.54	25.7	15.6	27.3	27.3
Copper	99%	8.19	30.8	19.4	39.4	39.4
Iron	99%	8,182	48,073	27,629	62,941	62,941
Lead	99%	3.39	288	24.0	132	132
Magnesium	100%	1,187	6,198	3,743	9,373	9,373
Manganese	100%	1.12	3,276	1,074	2,491	2,491
Mercury	51%	0.050	0.124	0.054	0.229	0.229
Nickel	99%	12.1	100	24	134	134
Potassium	97%	518	2,339	1,710	3,307	3,307
Selenium	25%	0.091	5.41	-	-	5.41
Silver	0%	-	-	-	-	-
Sodium	100%	16.6	2,422	175.6	1,962	1,962
Thallium	47%	1.79	8.92	3.67	15.7	15.7
Vanadium	99%	9.8	44.3	39.4	57.3	57.3
Zinc	99%	28.8	1155	84.46	240	240

Notes:
Units are mg/kg.
The range of background levels shown are based on background as determined for the following populations:
- Data combined by soil associations, KCB, KSU, SMO (ie., 3 datasets w/ 24 samples each).
- Data combined by sample depth, 0-12in., 24-36in., and 48-60in. (3 datasets w/ 24 samples each).
- Data combined by sample depth within each soil association (9 datasets w/ 8 samples each).

Calculated background levels shown do not include maximum detected concentrations.
Frequencies of detection and the ranges of detected concentrations are for n=72.
Minimum and maximum detections that tested as outliers for some populations were removed prior to statistical evaluation.
Some minimum detected concentrations shown represent 1/2 the detection limit (DL) for nondetects.

Table 19
Comparison of Recommended Background Levels to Health-Based and Groundwater Protective Levels
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Metal	Recommended Background Level	USEPA Region 9 PRG		MDNR CALM				USEPA SSL	
		Residential	Industrial	Scenario A	Scenario B	Scenario C	C_{leach}	DAF 20	DAF 1
Aluminum	25030	76000	100000	-	-	-	-	-	-
Antimony	3.93	31	410	85	120	300	-	5	0.3
Arsenic	24	22 (noncancer)	230(noncancer)	11	11	14	-	-	-
		0.39 (cancer)	1.6 (cancer)	-	-	-	-	-	-
Barium	650	5400	67000	14000	20000	51000	1700	1600	82
Beryllium	1.82	150	1900	0.05	0.07	0.2	130	63	3
Cadmium	3.94	37	450	110	150	380	11	8	0.4
Calcium *	17826	-	-	-	-	-	-	-	-
Chromium III	38.8	100000	100000	2100	3000	4500	38	-	-
Chromium VI	-	30	64	-	-	-	-	38	2
Cobalt	27.3	900	1900	-	-	-	-	-	-
Copper	39.4	3100	41000	1100	3100	4700	-	-	-
Iron	62941	23000	100000	-	-	-	-	-	-
Lead	132	400	750	260 ~~210~~	260 ~~210~~	260 ~~210~~	-	-	-
Magnesium *	9373	-	-	-	-	-	-	-	-
Manganese	2491	1800	18000	3700	5200	11000	-	-	-
Mercury	0.229	-	-	0.6	0.8	1	3.2	-	-
Nickel	134	1600	20000	4800	6700	17000	170	130	7
Potassium *	3307	-	-	-	-	-	-	-	-
Selenium	5.14	390	5100	300	410	970	4.3	5	0.3
Silver	-	390	5100	140	200	450	26	34	2
Sodium *	1962	-	-	-	-	-	-	-	-
Thallium	15.7	5.2	67	17	24	61	2.8	-	-
Vanadium	57.3	550	7200	1500	2100	5300	-	6000	300
Zinc	240	23000	100000	38000	53000	130000	3000	12000	620

Note:
All units are mg/kg.
Asterisks indicate metals that are essential nutrients.

Table 18
Recommended Background Levels for Metals
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Metal	Frequency of Detection	Minimum Detection	Maximum Detection	Minimum Calculated Background Level	Maximum Calculated Background Level	Recommended Background Level
Aluminum	100%	4,175	20,059	16,154	25,030	25,030
Antimony	8%	1.93	3.93	1.93	2.92	2.92
Arsenic	100%	0.647	18	10.4	24	24
Barium	100%	5.18	457	192	650	650
Beryllium	99%	0.368	1.43	0.93	1.82	1.82
Cadmium	85%	0.274	11.6	0.831	3.94	3.94
Calcium	100%	924	172,030	5,020	17,826	17,826
Chromium	99%	6.66	29.9	24.8	38.8	38.8
Chromium VI	0%	-	-	-	-	-
Cobalt	99%	4.54	25.7	15.6	27.3	27.3
Copper	99%	8.19	30.8	19.4	39.4	39.4
Iron	99%	8,182	48,073	27,629	62,941	62,941
Lead	99%	3.39	288	24.0	132	132
Magnesium	100%	1,187	6,198	3,743	9,373	9,373
Manganese	100%	1.12	3,276	1,074	2,491	2,491
Mercury	51%	0.050	0.124	0.054	0.229	0.229
Nickel	99%	12.1	100	24	134	134
Potassium	97%	518	2,339	1,710	3,307	3,307
Selenium	25%	0.091	5.41	0.202	0.418	0.418
Silver	0%	-	-	-	-	-
Sodium	100%	16.6	2,422	175.6	1,962	1,962
Thallium	47%	1.79	8.92	3.67	15.7	15.7
Vanadium	99%	9.8	44.3	39.4	57.3	57.3
Zinc	99%	28.8	1155	84.46	240	240

Notes:
Units are mg/kg.
The range of background levels shown are based on background as determined for the following populations:
- Data combined by soil associations, KCB, KSU, SMO (ie., 3 datasets w/ 24 samples each).
- Data combined by sample depth, 0-12in., 24-36in., and 48-60in. (3 datasets w/ 24 samples each).
- Data combined by sample depth within each soil association (9 datasets w/ 8 samples each).

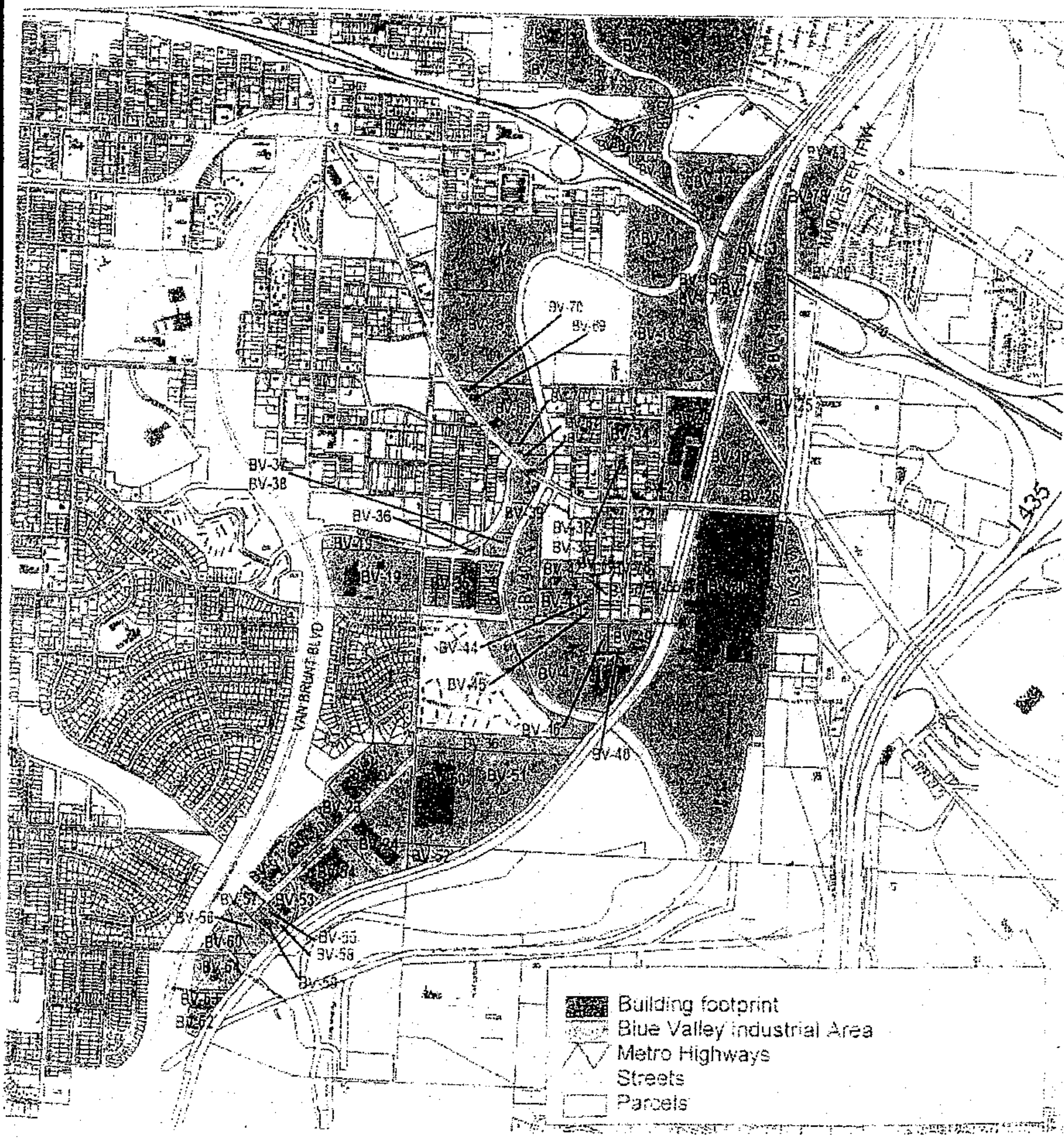
Calculated background levels shown do not include any based on maximum detected concentrations.
Frequencies of detection and the ranges of detected concentrations are for n=72.
Minimum/maximum detections that tested as outliers for some populations were removed prior to statistical evaluation.
Some minimum detected concentrations shown represent 1/2 the detection limit (DL) for nondetects.

Table 19
Comparison of Recommended Background Levels to Health-Based and Groundwater Protective Levels
Blue Valley Soils Background Study Report
Brownfields Showcase Project

Metal	Recommended Background Level	USEPA Region 9 PRG		MDNR CALM				USEPA SSL	
		Residential	Industrial	Scenario A	Scenario B	Scenario C	C_{leach}	DAF 20	DAF 1
Aluminum	25030	76000	100000	-	-	-	-	-	-
Antimony	2.92	31	410	85	120	300	-	5	0.3
Arsenic	24	22 (noncancer)	230(noncancer)	11	11	14	-	-	-
		0.39 (cancer)	1.6 (cancer)	-	-	-	-	-	-
Barium	650	5400	67000	14000	20000	51000	1700	1600	82
Beryllium	1.82	150	1900	0.05	0.07	0.2	130	63	3
Cadmium	3.94	37	450	110	150	380	11	8	0.4
Calcium *	17826	-	-	-	-	-	-	-	-
Chromium III	38.8	100000	100000	2100	3000	4500	38	-	-
Chromium VI	-	30	64	-	-	-	-	38	2
Cobalt	27.3	900	1900	-	-	-	-	-	-
Copper	39.4	3100	41000	1100	3100	4700	-	-	-
Iron	62941	23000	100000	-	-	-	-	-	-
Lead	132	400	750	210	210	210	-	-	-
Magnesium *	9373	-	-	-	-	-	-	-	-
Manganese	2491	1800	18000	3700	5200	11000	-	-	-
Mercury	0.229	-	-	0.6	0.8	1	3.2	-	-
Nickel	134	1600	20000	4800	6700	17000	170	130	7
Potassium *	3307	-	-	-	-	-	-	-	-
Selenium	0.418	390	5100	300	410	970	4.3	5	0.3
Silver	-	390	5100	140	200	450	26	34	2
Sodium *	1962	-	-	-	-	-	-	-	-
Thallium	15.7	5.2	67	17	24	61	2.8	-	-
Vanadium	57.3	550	7200	1500	2100	5300	-	6000	300
Zinc	240	23000	100000	38000	53000	130000	3000	12000	620

Note:
All units are mg/kg.
Asterisks indicate metals that are essential nutrients.

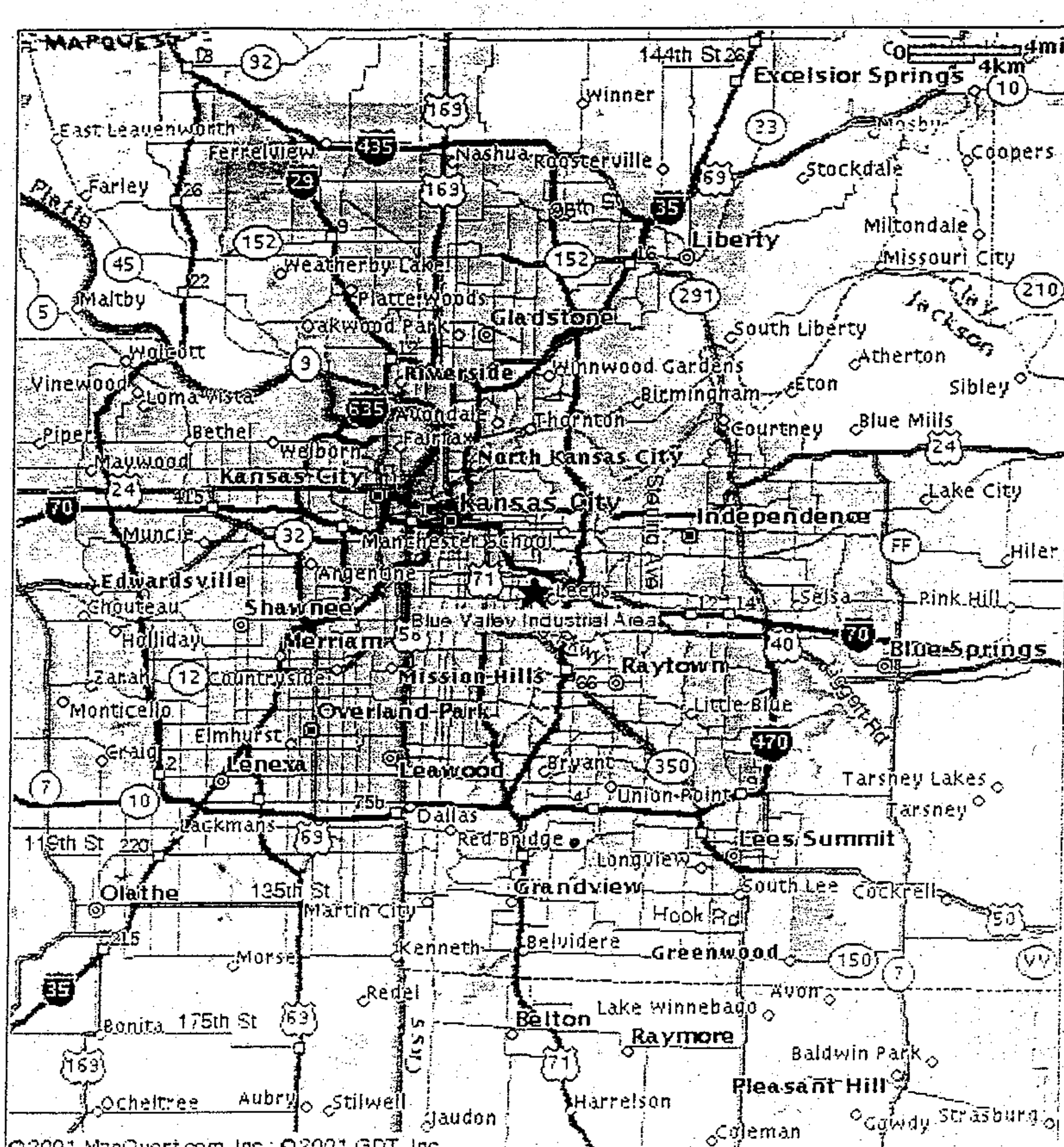
FIGURES



from: EDC, 1998

MAP NOT TO SCALE

Figure 2
Blue Valley Renewal Project Area
Soils Background Study Report
Brownfields Showcase Project



from: 2001 Mapquest.com

MAP NOT TO SCALE

Figure 1
General Location Map
Blue Valley Soils Background Study Report
Brownfields Showcase Project